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International

EFA survives in modified form

Germany's earlier call for a fundamental reappraisal of the European Fighter Aircraft programme – with a view to transforming it into a downgraded and supposedly cheaper machine – cast doubts on the viability of the entire project in the final quarter of 1992. Only after German defence minister and arch EFA-opponent Volke Rühe suffered a loss of stature within his own political party, and was accused of exaggerating Italian and Spanish concerns, did the aircraft's prospects undergo a revival.

Throughout this time, the United Kingdom avowed its intention of proceeding alone with the programme – a bluff which fortunately was not called. The nadir of EFA fortunes occurred in October, when both Spanish and Italian governments issued 'go-slow' orders to their participating aerospace firms. Italy halted all new investment in EFA on 10 October, while Spain indicated five days later that it was doing the same. Only the UK then remained an active member of the four-nation consortium. Simultaneously, the first flight of prototype DA1 receded further as double-checking of the computerised flight control system appeared certain to continue into January 1993. DA2, the UK-built aircraft, began engine runs on 30 August.

A German-inspired study completed on 16 October revealed the 'New EFA' (NEFA) – or, more accurately, seven possible variations on the EFA theme with single or twin engines (including three types of single-engine fit); with or without canards; and offering optional cranked-wing configuration. Only two of the seven would be cheaper than EFA – Germany's reason for refusing to go ahead with the original design – and these were seen to be substantially inferior to developed versions of MiG-29 and Su-27.

Cost estimates for NEFA were based on 250 for the UK, 150 for Germany, 130 for Italy and 72 for Spain. However, Italy is looking at options for 110, and even only 90 aircraft. The most effective variant appeared to be a simplified version of the basic EFA with reduced avionics and an APG-65 radar (as now being fitted in German Phantoms) instead of the purpose-designed ECR90. This might just have come within German government demands for cost savings. Volke Rühe rejected it out of hand, but the Luftwaffe fought hard to have it adopted. It was envisaged that other nations would be able to pick and choose from the various options and thereby obtain an EFA suited to their financial means.

As it finally sank in that NEFA would represent the worst of the financial and operational effectiveness worlds, the German position shifted in November from its outright rejection of the original design. Following a meeting on 10 November between UK Prime Minister John Major and German Chancellor Helmut Köhl, a new atmosphere of reality began to emerge. Requirements were further discussed at a joint chiefs of staff conference on EFA held on 20 November.

Success was achieved at a four-nation defence ministers' conference on 10 December, following which development was fully resumed by all participants. Now named Eurofighter 2000, the aircraft has had its in service date put back until 2000, given that a production decision is made in 1995. There will be some flexibility in EFA equipment fit, allowing Germany to claim success in having achieved a 30 per cent reduction in costs by resorting to APG-65 radar, simpler self-defence systems, and possibly other changes from the base-line. The RAF is likely to specify the purpose-designed ECR-90 radar and will have the fullest possible avionics standard.

Above: In 1992 this No. 2 Esc/Sm F-16 was bailed back to SABCA for trials, including employment of the AS30L laser missile.

Below: To celebrate its 50th anniversary (and 26 years flying the Starfighter), 102° Gruppo, 5° Stormo painted this F-104S.

Russian skies opened

The UK became the first nation to undertake aerial photography over Russia and Byelorussia under the Open Skies policy when the A&AEE's Andover C.Mk 1(PR) XS596 was deployed on to Shatlovo 2 September. Accompanied by an An-30 'Clank', the aircraft operated over the two ex-Soviet territories between 3 and 11 September. Two former No. 60 Squadron Andovers (XS596 and XS641) were modified (Mod 207) with underfuselage cameras in 1990, their most obvious external change being deletion of the port forward freight door and insertion of a window in its place.

Western Europe

AUSTRIA:

AAMs for Drakens

Concerned by regular airspace incursions of Serbian aircraft participating in the Yugoslav civil war, Austria revealed plans to arm its force of 24 Saab 35 Drakens with missiles – probably AIM-9 Sidewinders, for which the aircraft were wired during their previous service with the Swedish air force. Until the 1989 delivery of anti-tank missiles, Austria had never possessed missiles of any kind, having been forbidden to do so by the 1955 treaty ending 10 years of Allied occupation after World War II. At present, its Drakens carry only the internal 30-mm ADEN cannon.

BELGIUM:

Fighting Falcons for sale

The number of F-16 Fighting Falcons offered for sale from January 1993 onwards was revealed to be approximately 45 – for which one possible customer was understood to be Greece. Of 160 aircraft delivered to the FAB/BLu, 135 remained in service at the end of 1992, these to be reduced to 72 in service plus a reserve of about 20. Reserve requirements are in dispute, the air force chief of staff having claimed that 120 machines are necessary to keep 72 combat-ready.

FRANCE:

Rafale requirements revised

The revised French requirement for Dassault Rafales was unofficially announced to be 140 two-seat and 95 single-seat aircraft. The total of 235 is 15 down on the original target – a shortfall made necessary by the additional cost of the two-place aircraft. Rafale was originally cast as a single-seater, except for the operational trainer version, but the Gulf War caused France to think again and specify two crew for some combat roles.

A slow build-up in Rafale production was indicated by the announcement of plans to order only two aircraft in the 1993 French defence budget: one for the air force – whether single- or two-seat is unknown – and one naval Rafale M, both to be delivered in 1996. The navy plans to have up to 10 Rafales in service by 1998, while the first air force squadron will form in 2000. The third pre-series Rafale, two-seater B01, was taken from St Cloud to Istres flight-test centre by road in November, from where it was due to fly during the first quarter of 1993. SNECMA's M88 reheated turbofan, which powers the Rafale, gained its production certification on 30 October.

Dash 5 conversion for Mirage 2000Cs

Ending speculation, France announced that the Mirage 2000Cs of EC 2 at Dijon are to be upgraded to the latest 2000-5 standard – a move first suggested by Dassault as a 'seal of approval' which would improve the recently static sales of the current Mirage. The first 37 2000Cs (of which six have been lost) were built for EC 2 with M53-5 engines and Thomson-CSF RDM radar, those which followed having uprated M53-P2s and intercept-optimised Dassault/T-CSF RDI radar. Surviving aircraft – beginning with the first 15 in 1994 – are to jump a generation with receipt of T-CSF RDY radar and a new central processing unit, comprehensive ECM suite and the ability to launch the forthcoming MATRA MICA air-to-air missile. Pakistan had expressed an interest in buying France's early Mirage 2000Cs, but this latest move implies that the project has lapsed.

Mirage F1 transfer plans

Mirage F1CRs in three squadrons of the 33 Escadre de Reconnaissance are expected to transfer from Strasbourg/Entzheim to Reims/Champagne during 1993/94, and not – as first thought – to Colmar, where EC 13's new Mirage F1CTs will now remain. EC 30, the current Reims resident, is to stand down as a Mirage F1C interceptor wing. It is unlikely that ER 33's squadrons will survive the move intact, as the disbanding 30 wing contains the famous 'Normandie-Niémen' squadron (currently EC 2/30), the name of which is almost certain to be perpetuated. The first Mirage F1CTs for EC 1/13 were delivered to Colmar on 6 November, having completed initial pilot conversion at Mont-de-Marsan under the supervision of CEAM.

France joins US, UK in southern Iraq

Deployment of eight Mirage 2000Cs of EC 5 from Orange/Caritat to Dhahran,

Saudi Arabia, to watch over southern Iraq began with the first four on 1 September and continued with four more and a C-135FR tanker a few days later. Opération Alysse is the French component of the coalition air surveillance force operating below 32° south to protect the Marsh Arabs from Saddam Hussein. The RAF equivalent is Operation Jural; the US name is Southern Watch.

Atlantic 1s bow out

Disposals of the French navy's first-generation Atlantics began at Nîmes-Garons on 29 September with the sale of Nos 15, 27, 37, 38 and 47 – all of which were offered minus engines and avionics. The MR force is being upgraded with Atlantique 2s.

Airbus buy confirmed

As expected, France announced in the fall that two secondhand Airbus A310-300s are to be bought by CoTAM (Air Transport Command) as replacements for two of its four Douglas DC-8s based at Roissy with ET 3/60 'Esterel', the long-range transport squadron. The first will be delivered later in 1993, the second in two years' time. France had examined the possibility of replacement DC-8s or even the new Antonov An-70 before opting for Airbuses. The first DC-8 to be withdrawn will be outfitted to SARIGUE standard as an Elint aircraft to replace the current DC-8-55 with EE 51 at Evreux.

GERMANY:

Revised Luftwaffe organisation

Further changes to the 4th Air Force Structure plan made public in the fall indicated a reduction from five to four in the number of air divisions. A 5th Division formed at Eggersdorf in October 1990 to administer units of former East Germany, but will move to Berlin and become 3 Division. The unit of this designation currently at Kalkar, administering attack and reconnaissance wings in north-west Germany, will disband and redistribute its assets. In future, 3 Division will comprise JG 75 at Laage from 1994 with F-4Fs (ex-JG 72 from Rheine-Hopsten), JG 73 at Falkenberg from 1995 operating one F-4F squadron from disbanded JBG 35 from Pferdsfeld-Sobernheim and one squadron of MiG-29s (ex-JFG3/Erprobungsgeschwader at Preschen), Aufklärungsstaffel S at Laage with 10 Grob Egrett D500 reconnaissance aircraft, and No. 2 SAM Wing. No Tornados will be based in the east because nuclear-capable aircraft are prohibited there under the terms of the German unification treaty. Beginning a series of unit disbandments over the next couple of years, reconnaissance Phantom wing AKG 51 held its 'last [beer] call' at Bremgarten on 17 September.

Alphas reprieved

After consideration of its training requirements, the Luftwaffe decided to retain some Alpha Jets for advanced instruction. JBG 49 at Fürstenfeldbrück will keep 45 aircraft to provide Tornado lead-in training for students fresh from the T-37/T-38 pilot's course in the USA. The requirement will be reconsidered after three years, when the Alphas will be either refurbished by Dornier or replaced by additional T-38 hours at the American schools.

Above: A light grey air defence scheme is beginning to appear on Luftwaffe F-4Fs, displayed by this JG 74 aircraft.

Right: The Dutch BO 105CB display team is provided by the crews of 299 Squadron at Deelen. Its future was in some doubt in late 1992 due to helicopter availability problems.

EGRETT order confirmed

Ending protracted speculation, Germany elected to go ahead with purchase of EGRETT D-500 high-altitude reconnaissance aircraft for delivery between 1997 and 2001. Nine production machines and a refurbished prototype are reportedly involved, but one source reports that an 11th aircraft – a two-seat trainer – is being acquired.

New transport wing

Lufttransportgeschwader 65 was formed in what used to be East Germany to combine several previously independent transport squadrons. With HQ at Neuhardenberg (the current name for Marxwalde) it comprises four Lufttransportstaffeln (Air Transport Squadrons): 1 LTS with two Tu-154Ms (ex-TG 44), four LET L-410s (ex-VS 14) and six Mi-8Ss at Neuhardenberg; 2 LTS (formerly THG 34) at Brandenberg/Briest with Mi-2s and Mi-8PS/Ts; 3 LTS (formerly TFS 24) at Dresden/Klotzche with 12 An-26s; and 4 LTS at Berlin/Schönefeld with all three Il-62s (ex-TG 44).

GREECE:

Belated Mirage delivery

Having begun in March 1988, delivery was only completed on 18 November of 40 Dassault Mirage 2000EG interceptors and BG two-seat trainers assigned to 331 and 332 Mire of 114ª Pterix Mahis at Tanagra. Greece halted deliveries at the 28th machine in October 1989 with complaints that the Thomson-CSF RDM radar was below standard and only agreed to resumption of acceptances earlier in 1992.

ITALY:

Harrier II follow-on order

As expected, Italy announced on 18 November that it had placed a further order for 13 radar-equipped AV-8B Harrier II Plus aircraft to be delivered to the navy from late-1995 onwards. Two TAV-8B trainers are already in service and three AV-8B-Pluses from FY1991 contracts are already earmarked for Italy. The prototype 'Plus' made its initial flight on 22 September.

NETHERLANDS:

SAR helicopter decision

Three Agusta-Bell 412SP helicopters were bought by the Royal Netherlands Air Force to replace the four survivors of five Alouette IIIs serving with the SAR Vlucht at Leeuwarden. Deliveries will begin late in 1993. The AB 412s represent a considerable improvement over the single-engined Alouettes which regularly make over-water flights covering the NATO weapons ranges around the Friesian Islands and provide a medical evacuation service for the islanders.

Army aviation renamed

Final preparations were being made at the close of the year for re-naming the helicopter support force operated by the KLu on behalf of the Netherlands army. The Groep Lichte Vliegtuigen (GpLV – Light Aircraft Group) has been factually incorrect since the last Super Cubs were withdrawn in 1976, and so became the Groep Helikopters on 1 January 1993. Current status is 298 and 300 Squadrons with Alouette IIIs and 299 Squadron operating BO 105s. It is planned to buy 40 armed helicopters in 1993 to replace the Alouettes.

F-16s become dual-capable

Training was completed late in 1992 to allow all eight F-16 squadrons to become dual-capable in CWI (clear-weather interception) and FBA (fighter-bomber attack), whereas previously they had majored in one role only. Beginning on 8 January 1993, the Volkel wing has been providing two aircraft on 10-minute QRA (Intercept), its residents' former roles being nuclear strike (No. 311 squadron), FBA (No. 312) and reconnaissance (No. 306). The last-mentioned, along with No. 315 from Twenthe and No. 322 at Leeuwarden, are expected to be the squadrons dedicated to support NATO's Rapid Reaction Force. The KLu has a requirement for a radar-guided AAM to extend the F-16's capabilities into all-weather interception.

Consideration is being given to relocating F-16A pilot training from Tucson, Arizona (167th FG, USAF ANG) to Hato, in the Netherlands Antilles, when the present agreement expires in 1995. About a dozen KLu F-16A/Bs serve at Tucson in USAF markings.

SPAIN:

Defence cuts

Spain announced defence cuts of 10 per cent for 1993, putting in doubt its ability to fund the EFA. The planned purchase of eight additional EAV-8B Harrier II aircraft for the navy is said not to be affected, although upgrading of the aircraft with radar will be abandoned. Defence minister Jose Miguel Hernanzez Vasquez has re-

signed in protest at the cuts. During September, Germany's defence minister claimed to have the backing of Italy and Spain in his bid to have EFA abandoned, but Italy quickly distanced itself from this statement.

SWEDEN:

First production Gripen

Piloted by Reino Lidvik, Sweden's first production JAS 39 Gripen, 39101, made its 44-minute initial flight on 10 September at Saab's Linköping airfield, where it will be based for development work, replacing the lost prototype 39-1. Operational trials were being undertaken by the Defence Material Administration (FMV) during the autumn as a prelude to acceptance of 39102 by the SAF next spring. Pilot training will begin in October 1993 at Satenäs, where one squadron of F7 has been selected as the Gripen OCU. However, it will have to operate single-seat aircraft initially, as the first JAS 39B operational trainer is not due to fly until 1996. During the fall, Saab was offering an export version of the aircraft, designated JAS 39X, to countries allegedly wavering on an EFA purchase, but this variant appeared to have been overtaken by the renewed EFA commitment made in December.

TURKEY:

Black Hawk selected

Turkey agreed in principle to buy up to 200 Sikorsky S-70A (UH-60) Black Hawk utility helicopters, the initial procurement involving 25 direct from the USA late in 1993, plus 50 assembled locally by the TUSAS factory at Mürted. Most are required by the army, which operates some 200 Bell and Agusta UH-1 Iroquois. The gendarmerie, already flying S-70s, turned to Russia for Mil Mi-17 'Hips' as its next helicopter and signed a purchase agreement in Ankara on 5 November. The number of helicopters has not been revealed, although all will be paid for with food exports and construction services.

Anti-rebel operations

Turkish combat aircraft made two air strikes on Kurdish PKK guerrilla bases in northern Iraq late in August following a battle between the rebels and government troops in the town of Sirnak. USAF, French and RAF aircraft protect the Kurds from similar air attacks by Iraqi aircraft, but do not interfere with Turkish operations. Late in October, Turkish fighter-bombers killed 13 Kurdish civilians during an attack on a village in UN-protected northern Iraq as Turkey completed a major two-week air and ground offensive involving an entire army division penetrating 15 miles (24 km) across the border. During the operation, 1,000 rebels attempting to establish an independent Kurdish state were killed.

A-10 Thunderbolt offer

Turkey could become the first operator outside the USAF to receive A-10A Thunderbolt IIs if it were to accept a US arms package offered in October. Under the 'trickle-down' process made necessary by the CFE arms limitation agreement, the US proposes the transfer of 50 A-10s over the next three years, together with 50 AH-1 Cobra attack helicopters surplus to Army requirements – the first 28 of these due for delivery in 1993 and the balance by 1997. Turkey has asked for the A-10s to be upgraded with night vision systems before delivery. The A-10s and AH-1s will be particularly useful in the Turkish operations against Kurdish separatist groups.

Tankers to be bought

Also in prospect for Turkey are three tankers of a type yet to be selected. The THK currently has no aerial refuelling capability but decided in October to launch a feasibility study. Recipient aircraft would include the F-16 Fighting Falcon, the 100th locally-built example of which was delivered in October.

Eslla 002 of the Spanish navy is based at Rota and flies the Agusta Bell AB 212AS. These provide armed support and anti-ship capability.

Another 50th anniversary scheme is applied to a Sea Harrier FRS.Mk 1 of No. 899 Sqn, Royal Navy, the Yeovilton conversion unit.

UNITED KINGDOM:

RAF unit changes

Changes in the RAF effective from 1 September included disbandment of No. 233 OCU at Wittering and its reformation – still under Wing Commander Tony Harper – as the Harrier OCU/No. 20 (Reserve) Squadron. At the same time, the Hawk Aircraft Engineering Defect Investigation Team moved base from Brawdy to Chivenor. On 1 October, the Nimrod force at St Mawgan was officially stood down, with No. 236 OCU transferring to Kinloss to become No. 42 (Reserve) Squadron and its former 'shadow' (No. 38 Squadron) disbanding. In fact, the movement of aircraft took place earlier, the last Nimrod to leave St Mawgan being XV242 on 9 September.

Suspicions were raised that the Buccaneer S.Mk 2B will remain in service beyond the originally-planned withdrawal date of 1 April 1994. No. 208 Squadron was intended to disband on that date and replace No. 2 Training Squadron within No. 4 FTS at Valley, but No. 234 Squadron reformed at Valley on 1 November to operate Hawks alongside No. 74 Squadron, implying a delay in availability of the No. 208 number plate.

RN Canberras withdrawn

The last three of 10 Royal Navy Canberra TT.Mk 18 target-tugs were retired from the Yeovilton-based Fleet Requirements and Air Direction Unit in December and replaced by Falcon 20s operated by Flight Refuelling Ltd. For the final year, the FAA had five TT.Mk 18s on strength, two of which were maintained in storage at St Athan at any time. They were WH887 '847', WJ574 '844', WJ614 '846', WK126 '843' (storage) and WK142 '848' (storage).

Army Air Corps base transfers

Announcements in the fourth quarter of 1992 associated with the Army's partial withdrawal from Germany and relocation to East Anglia, revealed that two AAC regiments are to move to the former RAF Wattisham, while the 24th Air Mobile Brigade at Catterick is to gain the services of a fourth squadron at another ex-RAF airfield, Dishforth.

At present, main AAC forces in Germany are three regiments attached to a similar number of ground forces' divisions, two of each earmarked to return to the UK. Each regiment has two attack and one reconnaissance squadrons, all with a mixture of Gazelle AH.Mk 1s and Lynx AH.Mk 1/AH.Mk 7s. These are 1 Regiment, Hildesheim: 651 and 652 Squadrons (attack) and 661 Squadron; 3 Regiment, Soest: 653 and 662 Squadrons (attack) and 663 Squadron; and 4 Regiment, Detmold: 654 and 659 Squadrons (attack) and 669 Squadron.

Transfer of 3 Regiment to Wattisham will take place in July 1993, followed by 4 Regiment in March 1995. Wattisham will also gain 71 Aircraft Workshops and 2 Aircraft Support Unit. One squadron from 7 Regiment at Netheravon will join 9 Regiment at Dishforth. The current state of 7 Regiment is 656 and 658 Squadrons, both Scout AH.Mk 1 and Gazelle AH.Mk 1; 2 Flight, Gazelle; and 8 Flight, Agusta 109 (at Hereford). 9 Regiment comprises 657 Squadron, Lynx AH.Mk 1 and Gazelle; 664 and 672 Squadrons, Lynx AH.Mk 9. By 1995, 24th Air Mobile will have 3, 4 and 9 Regiments in its support.

In addition, the AAC will form new TA (Territorial Army reservist) flights at Netheravon (replacing the squadron moved to Dishforth), RAF Shawbury and Edinburgh/Turnhouse, all in 1993. At present, the sole TA unit in the AAC is 666 Squadron, operating 12 Scout AH.Mk 1s at Middle Wallop.

SAR shuffle

Expected changes in the RAF SAR world were confirmed on 21 October, when it was revealed that two flights of No. 22 Squadron and one of No. 202

would disband and the remaining two flights of No. 22 receive Sea King HAR.Mk 3s. There are presently 19 Sea Kings and 14 Wessex HC.Mk 2s in the RAF SAR inventory, but the latter are to be replaced by six additional Sea King HAR.Mk 3As ordered in February 1992. The larger, long-range, radar-equipped Sea King will give better coverage, its capabilities augmented further by the issue of night vision goggles to pilots by mid-1993. The fleet of 25 Sea Kings will comprise 12 on standby with six flights, four with the OCU, two in the Falkland Islands with No. 78 Squadron, and seven in reserve or undergoing maintenance.

No change is planned in the remaining elements of the UK SAR service which comprise an RAF SAR standby helicopter at Aldergrove (No. 72 Squadron Wessex or No. 230 Squadron Puma); RAF Mountain Rescue Teams at Kinloss, Leuchars, Leeming, Valley, Stafford and St Mawgan; Royal Navy Sea Kings at Prestwick (819 Squadron; with HAS.Mk 6), Portland (772 Squadron with HC.Mk 4) and Culdrose (771 Squadron with HAR.Mk 5); and Coastguard civilian Sikorsky S-61s at Sumburgh, Stornoway and Lee-on-Solent.

Current and future states of the RAF SAR force are summarised below. It is unlikely that the squadrons and flights will retain their present designations, the probable outcome being division of Nos 22 and 202 Squadron into three flights each, one squadron (presumably No. 202) responsible for the three northern bases, the other taking Chivenor, Valley and Wattisham.

Current status	Base	Future status
No. 22 Squadron HQ	St Mawgan	not announced
No. 22 'A' Flight – Wessex	Chivenor	Sea King from 1 Apr 1994
No. 22 'B' Flight – Wessex	Leuchars	disbands 1 Apr 1993
No. 22 'C' Flight – Wessex	Valley	Sea King from mid-1996
No. 22 'E' Flight – Wessex	Coltishall	disbands mid-1994
SAR Training Unit – Wessex	Valley	Sea King at St Mawgan 1996
No. 202 Squadron HQ	Boulmer	not announced
No. 202 'A' Flight – Sea King	Boulmer	Sea King retained
No. 202 'B' Flight – Sea King	Brawdy	disbands 1 Apr 1994
No. 202 'C' Flight – Sea King	Manston	to Wattisham mid-1994
No. 202 'D' Flight – Sea King	Lossiemouth	Sea King retained
No. 202 'E' Flight – Sea King	Leconfield	Sea King retained
SK Training Flight – Sea King	Culdrose	SK OCU at St Mawgan from 1 Apr 1993
No. 78 'B' Flight – Sea King	Mt Pleasant,FI	Sea King retained

Above and right: In late 1992, Nos 3 and IV(AC) Squadrons of RAF Germany completed the move from Gütersloh to Laarbrüch, marking the occasion with a nine-ship formation. RAF Germany will become 2 Group of Strike Command on 1 April 1993.

RAF takes Omani Tornados

On 11 September, the RAF began taking delivery of eight additional Tornado F.Mk 3s (serials ZH552-559) originally ordered by Oman and then cancelled, increasing its procurement from 165 to 173. RAF Tornado F.Mk 3 squadrons are shortly to increase their complements to 18 aircraft each, beginning with Nos 43 and 11 Squadrons at Leuchars, which currently have 15. This may be made possible by the disbandment of one squadron during 1993.

RAF basic training units are now virtually fully-equipped with Tucanos. The blue band denotes 3 FTS at Cranwell.

Eastern Europe

BULGARIA:

New insignia

National aircraft markings were changed late in 1992 to a roundel of white (centre), blue and red, the same insignia also appearing on fins.

COMMONWEALTH OF INDEPENDENT STATES:

Arms production slowed

American estimates of weapons production in the former USSR, which became available in September, showed the expected decline in all classes of equipment. For the air, annual production totals were as follows:

	1989	1990	1991
Bombers	40	35	30
Fighters	650	575	350
Attack helicopters	100	70	15

New links with West

Fresh avenues of communication were opened between the CIS and the West on 14 October when a Kamov Ka-27 'Helix', coded 46 (red), from destroyer *Admiral Vinogradov* landed aboard the carrier USS *Ranger* and destroyer USS *Kinkaid* in the Arabian Gulf. The same helicopter became the first CIS aircraft aboard a British vessel when it alighted on destroyer HMS *Chatham* on 21 October.

Internal strife continues

Separatist forces in the Muslim enclave of Abkhazia used a shoulder- launched SAM to down a Georgian Mi-24 'Hind' on 5 October. The helicopter was apparently one of several Georgian aircraft of unknown types which had raided the north-western province following the rebels' capture of Gagra, one of its principal towns, a week earlier.

POLAND:

Production Orlik begins trials

Military flight trials were begun at Powidz in October by the first production PZL-130TB Orlik turboprop trainer (c/n 012). The PLW has on order 48 of this version, powered by a Walter M-601 engine, and was anticipating (perhaps in vain) accepting seven before the end of 1992. Other versions of Orlik offered for export have a Pratt & Whitney PT6 turboprop.

I-22 Iryda enters service

The first two of six pre-production PZL I-22 Iryda advanced jet trainers were delivered to the PLW on 23 October and are expected to be followed by a batch of 36 more machines, all of which will have a pair of 10.8-kN (2,425-lb) thrust PZL-5 engines. Later versions are being planned for operational use with either 14.7-kN (3,307-lb) thrust WSK K-15 turbojets or 17.7-kN (3,968-lb) thrust D-18A turbofans. The operational models are designated M95 for reconnaissance and M97 for close support, the latter representing a redesign of the airframe with single-pilot cockpit, strengthened structure and increased wing span. Each will have eight underwing hardpoints and a centreline pylon for 30-mm gun (compared with 23-mm on I-22 trainers) or electronic sen-

Part of the drive to keep famous RAF squadron numbers 'alive', the Hawks of 7 FTS at Chivenor now wear the markings of Nos 19 (foreground) and 92 (background) Squadrons, both formerly RAFG Phantom operators.

sors, the M97's weapon load totalling 3500 kg (7,716 lb). The adaptable Iryda is also being offered with Turboméca Larzac, Rolls-Royce Viper or GE J85 engines.

ROMANIA:

MiG-21 upgrade

A surprising development during November was appointment of Israel Aircraft Industries to upgrade 100 Romanian MiG-21 'Fishbeds' – the first known instance of a former Warsaw Pact country appointing a Western contractor for such work. A prototype will be modified in 1993-94, following which a further three years will be spent on upgrading the MiG-21s with new radar, a mission computer, multi- function displays, a new nav/attack system and provision for carrying laser-guided bombs and advanced types of missile.

(Former) YUGOSLAVIA:

Fragmented air force

Serbia and Serb-aligned forces in former Yugoslavia hold most of the air assets. The 'old' Jugoslovensko Ratno Vazduhoplovstvo reformed on 19 May 1992, still as the JRV, but now serving the 'new' Yugoslavia: Serbia and Macedonia. Its previous organisation into four geographical corps has been replaced with one of three functional corps, of which No. 1 is responsible for air defence, No. 2 for ground attack, reconnaissance and transport, and No. 3 for logistics and depot-level maintenance. The Communist national insignia has been replaced by a roundel divided horizontally into blue (top), white and red bands and a similarly configured fin flash.

Fighting in 1992 centred on the dismembered Bosnia-Herzegovina, this comprising the UN-protected Serbian Republic of Krajina; the self-proclaimed Republic of Bosnia-Herzegovina (also Serbian) and remaining – but shrinking – elements of the former Bosnia-Herzegovina containing mostly Muslims under assault by Serbs. In the first-mentioned, the Helikopterska Eskadrila Militsija Krajina (Krajina Militia Helicopter Squadron) formed at Golubic on 5 April 1992 with a dozen SOKO-built Aérospatiale Gazelles and a few Mil Mi-8s. Krajina markings are the upper half of a disc, divided horizontally blue, red, blue and white surrounded by the Cyrillic script 'Militsija Krajina'.

Largest of the new air forces, that of the Republic of Bosnia-Herzegovina, formed on 19 May 1992 when federal forces withdrew. It has at least three operational squadrons based at Banja Luka: 'Vrbac Lynxes' (ex-JRV 238 Sqn/82 Air Div from Slovenia) with Oraos, Jastrebs and Galebs mentioned above; 'The Kerbers' (ex-711 Sqn) flying Gazelles; and the former 780 Sqn with Mi-8s, both helicopter units previously having been in 111 Regiment of 111 Brigade at Zagreb, Croatia. A flight of Gazelles at Pale, plus various impressed Cessna 172s and Antonov An-2s, completes the known flying element, but a regiment (previously No. 155) of SA-3 'Goa' SAMs is at Banja Luka. Roundel is red (top), blue and white with a similar fin flash, the latter worn by the militia's An-2 and SOKO J-20 Kraguj (one of each).

Middle East

IRAN:

Falcon 50s in service

Three Iraqi government Dassault Falcon 50 executive jets flown to Iran for sanctuary during the Gulf War were noted operating in Iranian military markings and serial numbers (9011-9013).

ISRAEL:

US weapons promised

Continuing with arms supplies promised to Israel in return for its co-operation during the 1991 Gulf War, the US announced on 26 September that deliveries would begin in 1993 of a further 24 McDonnell Douglas AH-64A Apache attack helicopters and 10 Sikorsky UH-60A Black Hawk support helicopters. All will be taken from the US Army's inventory. Israel already operates 18 Apaches, but the Black Hawks are the first of this type for the IDF/AF. The same agreement has already resulted in Israel receiving 10 Sikorsky CH-53A Stallions and 10 McDonnell Douglas F-15A Eagles from American surplus. Other deliveries promised include an undisclosed number of Bell AH-1S Cobras and 10 McDonnell Douglas TA-4J Skyhawks. Planned purchase of Beech A36 Bonanzas for pilot training has been abandoned and the competition reopened, resulting in an Aérospatiale TB-20 Trinidad being demonstrated to the IDF/AF in September.

Raids on Lebanon

Reacting to guerrilla attacks which killed six of its soldiers, Israel launched artillery barrages and armed helicopter strikes on Shia Muslim villages in southern Lebanon on 26 October. During the following day, fixed-wing combat aircraft raided Hizbollah terrorist camps in the Bekaa Valley.

SAUDIA ARABIA:

F-15 Eagle sale approved

A week after George Bush authorised sale of 150 F-16 Fighting Falcons to Taiwan, the US President's pre-election campaigning resulted in approval of a second long-expressed fighter aircraft requirement when Saudi Arabia was granted 72 McDonnell Douglas F-15 Eagles on 11 September. Complementing the 84 (remaining from 98) F-15C/Ds already in the RSAF inventory, the promised aircraft are designated F-15XP, being based on the F-15E Strike Eagle airframe, but mostly fitted with F-15C/D systems for ease of maintenance support. Although 48 of the F- 15XPs will be optimised for air-to-ground missions (and the balance for interception) they will lack the F-15E's interdictor capability. APG-70 radar will be 'detuned' to the level of the APG-63 of F-15C/Ds and will lack computerised mapping. Some F-15E ECM systems will be deleted, as will the ability to carry conformal fuel tanks and their lateral weapons pylons. Saudi Arabia will receive 48 night navigation and targeting pod sets for its F-15XPs, these being downgraded versions of the Martin Marietta LANTIRN system. Associated weapons in the $9,000 million package include 900 AGM-65D Maverick ASMs, 300 AIM-9S and 300 AIM-9M Sidewinder AAMs, 600 CBU-87 cluster bombs and 700 GBU-10/12 laser-guided bombs. Still to be decided is engine type, for while all the USAF's F-15s have P&W F100s, the Eagle can be fitted with the alternative GE F110.

No sooner had it been agreed than the F-15 sale ran into financial problems caused by the previously unthinkable situation of Saudi Arabia being financially embarrassed. Some weapons programmes have already been postponed or delayed, such as first AH-64A Apache deliveries being slipped by seven months until January 1993 and a proposed 1991 order for Patriot SAMs being put on ice. Britain's hoped-for Al Yamamah II programme of Tornado, Hawk and Westland WS-70 Black Hawk sales has been another victim of funding shortages following the 1991 Gulf War. The Tornado production line at Warton was progressively closing down during the final months of 1992 as the last aircraft passed through, although a restart to manufacture has not been ruled out.

SYRIA:

Air force expansion stalled

The change in the former USSR from Soviet socialist fraternity to Russian cash-on-the-nail has halted Syrian military expansion plans until at least some of the $11,000 million weapons debt to Moscow is cleared. Requirements awaiting an improvement in Syria's financial position include further MiG-29 'Fulcrums' and Su-24 'Fencers' to augment the 20 of each already in service.

A C-130E from the 314th Airlift Wing lands at Baidoa in October, part of the USAF airlift effort into Somalia.

One of the small fleet of lightplanes impressed into military service in the war in former Yugoslavia, this UTVA-75 wears the colours of the Bosnian republic, and features bomb racks under the wings.

Africa

SOUTH AFRICA:

Tucano selected

Despite having designed and built a prototype of its own turboprop trainer – the Atlas NGT – South Africa was reported to have selected EMBRAER's EMB-312 Tucano for SAAF basic pilot training. A formal exchange of contracts remained in the future, however, as the Brazilian government had yet to grant an export licence and the South African government was required to approve the expenditure of foreign funds. Only 40 turboprop trainers are initially required by the SAAF to replace its fleet of 106 North American T-6 Harvards, as only 80 of these are operated by the Central Flying School at Dunnottar and defence cuts have more than halved the requirement for new pilots.

SAAF reductions and unit moves

Shortly before 30 September, when disbandment of Mirage F1CZ-equipped No. 3 Squadron completed an initial round of SAAF strength reductions, a further series of disbandments and moves was announced. Principal changes involve closure of Pietersburg and Dunnottar; reduction of Durban to a helicopter enclave (presumably the Aérospatiale Pumas of currently resident No. 15 Squadron); withdrawal from service at the end of November of all nine Transall C.160Zs (forming part of No. 28 Squadron at Waterkloof); closure of the SAAF regiment training centre at Hoedspruit and incorporation of its role in the Gymnasium; stretching and cancelling unspecified programmes; and concentrating aircraft of the same type at a single base for economy of servicing.

In the above connections, No. 89 Combat Flying School at Pietersburg will disband and pass its Dassault/Atlas Cheetah Ds to No. 5 Squadron at Louis Tritchardt, augmenting Cheetah Es; No. 85 Combat Flying School (Atlas Impala 1/2 at Pietersburg), No. 83 Jet Flying School (Impala 1 at Langebaanweg) and No. 7 Squadron (Impala 2 at Langebaanweg) will all move to Hoedspruit; the CFS is to move from Dunnottar to Langebaanweg; and No. 31 Squadron, flying Aérospatiale Alouette IIIs and Pumas at Hoedspruit, will disband. No. 42 Squadron, recently re-equipped with the same Cessna 185s it discarded when issued with Atlas Bosboks, moved from Potchefstroom to Swartkop on 28 September. Tenders for the sale of 19 Bosboks closed on 14 September.

Eleven Mirage F1CZs remained in service on 30 September, from 16 delivered, eight having been written off. Explaining this peculiar arithmetic, two (203 and 204) were destroyed in a collision in February 1979 and their remains used to equip two new airframes with the same serial numbers, while 205 and 206, the victims of separate incidents, were combined as a second '205' in 1988.

TUNISIA:

Aero L-59 delivery

Initial indications of an order for Aero L-59E uprated versions of the L-39 Albatros were seen in October when the delivery flight of the first was interrupted by an emergency landing at Genoa, Italy. A month before, the L-39/59 production line at Vodochody, Czechoslovakia, showed no sign of Tunisian aircraft, only part of the Nigerian order for 30 L-39ZAs.

ZIMBABWE:

Hawk order complete

Three BAe Hawk Mk 60As which left the UK on 1 September completed the follow-on AFZ order for five aircraft, of which the initial two began their delivery flight on 16 June. Zimbabwe has also admitted placing an order in 1986 for an undisclosed number of MiG-29 'Fulcrums' which were later cancelled because of financial problems and a reduction in tensions with South Africa.

Far East

CHINA:

CIS weapons sought

Licensed production of Mikoyan MiG-31 'Foxhound' fighters was among several arms programmes under active consideration in Beijing late in 1992 as China sought to rectify some of the many shortcomings in its arsenal. The MiG-31 would meet a priority need for a fighter with a powerful radar able to act as a 'mini-AWACS'. Although seeming unusual to Western observers, such a concept is practised by MiG-31s in Russian service. Four MiG-31s in line abreast, with their 'Flash Dance' radars interconnected by datalinks, can sweep a 500 to 600-mile (804 to 965-km) front, refuelling in the air and intercepting hostile targets. A related priority is for an aerial tanker, resulting in interest being expressed in the Ilyushin Il-78 'Midas' – either for lease or purchase. If bought, the MiG-31 would be built in the F-7 (MiG-21) plant at Anshun, Guizhou Province, initially by Russian workers. Start-up would be with 24 kits and 48 from co-production, leading eventually to manufacture of complete aircraft and hand-over of the production line to China. Some of the early aircraft would be for Russian use.

INDONESIA:

Hawk commitment announced

Although a formal order was not expected until early in 1993, Indonesia announced formally on 19 October that it was planning to go ahead with an order for 24 BAe Hawks (reduced from a planned 40) to augment the survivors of 20 obtained in small batches during the 1980s.

JAPAN:

Second-generation AWACS targeted for 1993

Ending its procrastination on an AWACS platform – which resulted in the Boeing E-3 ending production before a decision could be made – the Japan Defence Agency brought forward by one year plans to obtain the projected successor, based on the Boeing 767. It is now intended to buy four 767s in the 1993 defence budget, each fitted with the same avionics as late production E-3s.

'Blue Impulse' reformed

Disbanded following a collision between two Mitsubishi T-2s in July 1991, the 'Blue Impulse' formation aerobatic team of the JASDF was re-established for the Japanese air display season in the fall of 1992. Only four, instead of six, T-2s are now operated by the team, due to a shortage of aircraft and pilots. Conversion to Kawasaki T-4s will be undertaken in time for the 1996 season, the team being attached to 4 Air Wing at Matsushima.

MALAYSIA:

More Wasps acquired

Having taken delivery of six ex-Royal Navy Westland Wasp HAS.Mk 1s for No. 499 Squadron during the late 1980s, the Royal Malaysian Navy is believed to have received five of the seven surviving (from 16 delivered) South African Wasps made

Seen at Ramstein Air Base on the same day in August 1992, these F-16C Block 40s are on delivery to Israel (above) and Egypt (below).

In September the RAF deployed six Tornado F.Mk 3s and four Harrier GR.Mk 7s (above) to Kuantan in Malaysia for an exercise to test the local Integrated Air Defence System in support of the Five Power Defence Arrangement. Other participating aircraft were provided by the RN, RAAF (Hornet, left), RNZAF, RSAF and RMAF.

redundant in 1991 and sold to an unnamed buyer in Singapore. Only two of the five are reported to be airworthy, however. Six further Royal Navy Wasps transferred to Malaysia in August may be used for spare parts.

TAIWAN:

Improved Ching Kuo cancelled

Although production is expected to continue of the AIDC Ching Kuo fighter, an impending US offer of long-denied General Dynamics F-16 Fighting Falcons was believed to be behind the unexpected cancellation on 26 August of the proposed uprated version. The first of an initial 10 pre-series and 60 production Ching Kuos was delivered on 9 March 1992, eventual requirements then being for 256 to replace Lockheed F-104G Starfighters and Northrop F-5E Tiger IIs by 1997. IDF II – Indigenous Defence Fighter No. 2 – was to have been an improved Ching Kuo with uprated engines (either a higher-rated version of the current Garrett/AIDC F125 or the new GE J101/SF) to be introduced at an unspecified point in production. It is now understood that production will be terminated after the 130 first-generation aircraft which will complement the 150 F-16s which Taiwan plans to buy.

F-16s offered by US

When publicly made by President Bush on 3 September, the American F-16 offer was greeted with only two cheers by the RoCAF, which was disappointed to hear that it was being promised only F-16A/Bs and not the F-16C/D version. The latter was claimed to be better suited to the RoCAF's needs, although its main advantage is in the option of two different types of engines with additional power, compared to the F-16A/B. Many of the subsequent avionics upgrades of the F-16 family have been incorporated in later production F-16A/Bs, making them far more capable than the aircraft of this designation which entered service in 1979. Air force commander General Lin Wen Li has suggested that Taiwan might not take up the full 150 Fighting Falcons, giving it the option to mix the type with Dassault Mirage 2000s.

Seen on air-test from Warton, one of the first batch of Hawk Mk 67s for South Korea demonstrates the revised nose contours of this Mk 60/100 hybrid. Twenty are on order.

Mirage 2000-5 agreement

Although no formal announcement was made, a contract was signed on 17 November for the sale to Taiwan of 60 Dassault Mirage 2000s. The order – first since 1987 for the Mirage 2000, apart from a cancelled Jordanian contract – is for the new 2000-5 version with Thomson-CSF RDY radar and MATRA MICA AAMs. Deliveries are expected to begin in 1995 and will include 1,000 MICAs and Magic 2s plus, possibly, the MATRA APACHE stand-off weapons dispenser.

Seasprite for navy

Despite having received 10 Sikorsky S-70M Seahawks, the RoC navy was authorised by Washington in September to acquire 12 USN surplus Kaman SH-2F Seasprite shipboard helicopters.

THAILAND:

Orion order go-ahead

The planned Thai navy order for Lockheed Orions was imminent at the year's end, five P-3As (two of them for spares breakdown) having been assigned from USN storage. Two will be converted to P-3T patrol aircraft and the third will become a UP-3T utility/trainer aircraft.

Australasia

AUSTRALIA:

Chinook upgrade agreed

After long deliberations, Australia agreed late in August to authorise conversion of four of its stored Boeing CH-47C Chinooks to CH-47D standard. The work will be undertaken by Boeing in the US, the remaining seven helicopters being sold to the US Army National Guard to cover most of the cost of the work.

F-111 airframes for stock

Purchase plans were revealed in October for the RAAF to acquire 18 USAF surplus GD F-111s. The aircraft will not be used to form an additional squadron, but stored with a view to eventual upgrading as the existing 24 F-111s of No. 82 Wing at Amberley become fatigued. In this way, the RAAF hopes to extend the F-111 fleet's operational life beyond the currently planned date of 2010.

Central America

NICARAGUA:

Helicopter force expanded

Nicaragua's fleet of Mil Mi-8 'Hip' armed/utility helicopters was almost doubled on 23 August when 23 more of the type arrived by sea at Managua, having been donated by Peru.

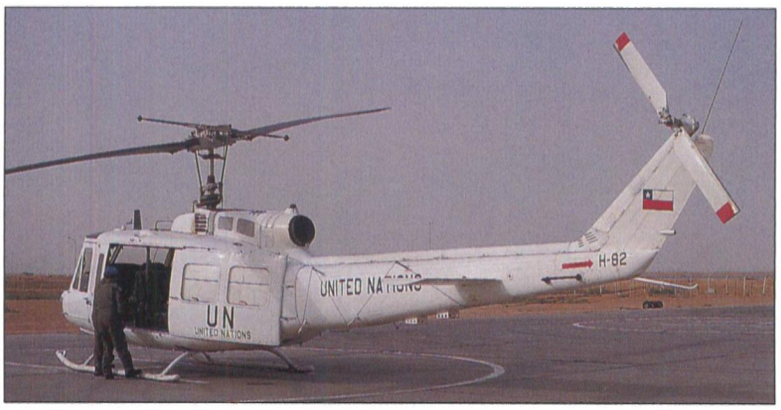
South America

ARGENTINA:

Skyhawks go ahead

Despite objections by the United Kingdom, which fought a short war with Argentina in 1982 over the latter's invasion of the Falkland Islands, confirmation was received in October that the FAA was to go ahead with purchase of 54 McDonnell Douglas A-4M Skyhawk fighter-bombers from US Navy stocks. Delivery of the first 36 was planned for January 1993, probably to augment the depleted two squadrons of A-4Ps within Grupo 5 at Villa Reynolds. Further equipment re-

In October 1992 a leased An-124 delivered back to Chile the UH-1Hs which had flown from Um Khasar in Kuwait in support of the UN Iraq-Kuwait Observation Mission. The Chilean involvement had begun in April 1991.



quested from the US included 10-12 Grumman OV-1D Mohawks for army aviation and two ex-USN Grumman S-2G Trackers. The latter are expected to join the S-2UP turboprop conversion line, increasing the Navy's fleet to eight. On the debit account, one of the Navy's five remaining Aermacchi M.B.339s was sold on the US civil register in mid-1992.

CHILE:

Pillan production ends

Manufacture of the ENAER Pillan basic trainer came to a temporary end in 1992 after delivery of the last of 12 to Paraguay. The remaining 100 machines were supplied to Chile (48 – reduced from a requirement for 80), Spain (41), Panama (10) and to ENAER (one) as the prototype Turbo Pillan. Having initially been rejected by the home air force, the turboprop-powered version, with an Allison 250-B17D, may now gain a production order. ENAER has begun manufacture of a further batch of Pillans in anticipation of follow-on orders.

New Dragonfly squadron

Grupo 3 was recently re-established at Base Aérea Maquéhue, Temuco, with a batch of 10 newly-received, USAF-surplus Cessna A-37B Dragonfly COIN jets. The survivors of 34 earlier A-37s are now concentrated within Grupo 12 at Punta Arenas.

VENEZUELA:

Abortive coup

Elements of the FAV were involved in the failed coup attempt which began at 0001 hours on 26 November and involved a rebel take-over of the air bases at Maracay (Grupo 16 with F-16 Fighting Falcons) and La Carlota (Grupo 4 operating transport aircraft). Two OV-10s and a Tucano were believed to have been shot down after aircraft attacked the President's headquarters at the Miraflores complex. The pilot of one ejected near La Carlota and was picked up by a passing motorist.

North America

CANADA:

Transport and tanker orders

Canada is to acquire five Airbus A310s to replace the five Boeing CC-137s of No. 437 Squadron at Trenton. All are to be bought from Canadian Airlines International: three in the 1992/93 defence budget and two in the following year. The two CC-137s fitted with wingtip refuelling pods are being replaced by tanker conversions of the Hercules, designated CC-130T. First of these, 130339, was exhibited at Farnborough, fitted with a pair of Flight Refuelling Ltd Mk 32B pods under the wings and a 3,600-Imp gal (16366-litre) fuel tank in the hold. The conversion was devised by Lockheed Aeronautical Systems, but installed by Northwest Industries in Canada, and will be applied to the five Hercules delivered to the CF in 1991. They are also receiving self-protection aids already applied to four of the fleet two years ago and destined eventually for all CC-130s: AN/AAR-47 missile approach warners, AN/ALE-39 chaff/flare dispensers and AN/ALR-39 radar warning receivers. CC-130T 130339 was delivered to No. 435 Squadron at Edmonton in June and all will have been received by the second quarter of 1993.

UNITED STATES:

S.211A trainer makes first flight

The first 'production' Grumman/Agusta S.211A trainer, being offered for the US JPATS, made its first flight on 17 September 1992 at Vergiate, Italy. Flown by Agusta chief pilot Carlo Colombo and bearing civil registry I-PATS, the aircraft is c/n 201 in the S.211/S.211A series. Compared with the S.211, the S.211A has a more powerful engine, additional load capability, and more fuel capacity; as of 7 November 1992, it had made eight flights. The S.211A is a two-place, stepped tandem-seat trainer weighing roughly 6,000 lb (2720 kg) and powered by a 3,180-lb (14-kN) static thrust Pratt & Whitney JT15D-5C turbofan engine.

S.211 production began in 1984, with 30 aircraft delivered to the Singapore Air Force for the primary training role. Since reaching initial operating capability in 1985, the S.211 has accumulated 60,000 hours performing this mission with several air forces. Haiti operates four S.211s, the Philippines 18.

This 'production' S.211A, which is not fully missionised for JPATS requirements, was scheduled to remain in Europe. A second S.211A, aircraft c/n 202, was to be fully equipped for JPATS, adding single-point pressure refuelling, selectable nosewheel steering and digital avionics. The latter aircraft was to make its first flight in January 1993, and was scheduled to be shipped to Grumman's Calverton, New York, flight test facility in May 1993. C/n 202 and a high-fidelity mock-up were to begin US demonstrations in the spring of 1993 when Grumman makes its formal proposal to the US Air Force, aiming toward JPATS source selection in the autumn of 1993.

In 1989-91, Grumman demonstrated two S.211 aircraft on tours around the United States in connection with JPATS, these being aircraft c/n 21 (I-SMTE) and c/n 42 (I-SMTF). Both are in lay-up at Calverton.

AV-8B Harrier II Plus first flight

The first radar-equipped McDonnell AV-8B Harrier II Plus (BuNo. 164129) made its first flight on 22 September 1992 at St Louis. The Harrier II Plus differs from its predecessors, both day- and night-attack AV-8Bs, in having Hughes AN/APG-65 multi-mode pulse-Doppler radar to enhance the night attack and close support mission. The radar installation extends the nose by 1 ft 5 in (0.43 m).

The US Marine Corps is committed to acquiring 27 Harrier II Plus aircraft. The first production example (BuNo. 164542) was scheduled for delivery to MCAS

The original programme may be long dead, but the two 'crank-wing' F-16XLs are alive, flying with NASA's Dryden Flight Research Facility on laminar flow work.

F-15E training is undertaken at Luke AFB with the 58th Fighter Wing. This machine is marked for the commander of the famous 'Triple Nickel' 555th FS.

Yuma, Arizona, in April 1993. In November 1992, Italy committed to the purchase of 13 Harrier II Plus aircraft, with an option for eight more, to join two TAV-8B trainers now serving with the Italian navy. First delivery will occur in 1995. The Spanish navy, already equipped with EAV-8B Harrier IIs, is interested in eight Harrier II Plus aircraft plus one TAV-8B trainer.

In a separate development, the Pentagon's Inspector General has determined that inadequate testing is the cause of numerous engine problems in operational AV-8Bs. The US Navy and Rolls-Royce have determined that a major redesign of the AV-8B's F-402 Pegasus engine's inlet guide vanes is needed to prevent them from overheating and failing. The report indicates that service AV-8Bs have an unacceptably high engine failure rate.

Most Marine Corps AV-8Bs are powered by 23,800-lb (105.9-kN) thrust Rolls-Royce F401-RR-408 Pegasus 11-61 which offers about 2,000 lb (8.9 kN) more thrust than the F401-RR-406A Pegasus 11-21E on early aircraft. The -408 Pegasus has also had compressor blade rubbing problems and Rolls-Royce is testing a modified engine in an effort to overcome them.

Low-cost V-22 Osprey being studied

The Bell-Boeing team developing the V-22 Osprey tilt-rotor aircraft has responded to a US Navy request by proposing a lower-cost alternative to the present aircraft. The 'no frills' V-22 would have a cruise speed reduced to 180 kt (206 mph; 333 km/h) from 265 kt (304 mph; 490 km/h) and would no longer be required to have a 2,100-nm (2,415-mile/3886-km) self-deployment capability. Changes include a reduction of range/payload capability on transport missions to 200 nm (230 miles/370 km) with a payload of 6,000 lb (2722 kg).

Funding was approved on 22 October 1992 for four production V-22 full-sized aircraft and for modification of two existing V-22s to meet revised requirements for a Marine Corps medium lift replacement for the Vertol CH-46 Sea Knight. The Clinton administration has indicated support for the V-22 Osprey in its current form, leaving unclear whether a 'downsized' version will be wanted. However, the day after V-22 funding was approved, six companies (Bell, Boeing, E. H. Industries, McDonnell Douglas, Piasecki and Sikorsky) received separate funding to explore converting existing helicopters. In theory, an ongoing cost and effectiveness analysis will determine by early 1994 whether the Marines should receive a full-scale V-22, a 'downsized' V-22, a modification of an existing helicopter design, or a new helicopter. In fact, most observers expect the V-22 to survive.

Bell, which has responsibility for nacelle design, is studying a new metallic drive shaft to replace the existing composite drive shaft, to prevent recurrence of the engine fire that destroyed the no. 4 Osprey (BuNo. 163914) at Patuxent River, Maryland, on 20 July 1992, killing seven. The mishap followed the 12 June 1991 crash in Wilmington, Delaware, of the no. 5 Osprey (BuNo. 163915) without loss of life.

B-2 flight testing expanded

The no. 5 prototype Northrop B-2 'Stealth Bomber' (82-1070) was delivered on 5 October 1992 to the US Air Force's 6520th Test Squadron at Edwards AFB, California, while the no. 6 B-2 (82-1071) was slated for delivery in January 1993. The total of six prototype aircraft includes two static test examples.

Flight tests of the Northrop B-2 at Edwards AFB, California, were expanded in late 1992 to include testing of the bomber's navigational accuracy and radar capability. The extended flights put the B-2 on a 3,100-mile (4990-km) 'box route' encompassing California, New Mexico, North Dakota and Washington.

The B-2 programme was scheduled to reach a further milestone in December 1992 when one of two static test aircraft was to be intentionally loaded until breaking. Both static test B-2s have already been evaluated at 'ultimate load', and the intentional destruction was expected to complete planned static and durability tests. The nos 3 and 4 B-2s, the static test articles, have no engines or other systems installed.

Vought is fabricating thicker aft decks for the B-2 to replace surfaces that cracked during earlier flight testing when exposed to hot exhaust flow. The first titanium alloy deck was scheduled for delivery to Northrop for installation on the left side of the no. 2 B-2 aircraft (82-1067) in June 1993.

OH-58D Kiowa Warrior funding continues

The US defence appropriation for fiscal year 1993 includes funding to retrofit 75 Bell OH-58D armed Kiowas to the more advanced OH-58D Kiowa Warrior standard, and to modify 36 OH-58As to become armed OH-58Ds. The OH-58D Kiowa Warrior differs from the armed OH-58D in having a reduced radar signature, laser protection, windshield coating, and an enlarged nose to house avionics previously located in the crowded cockpit. The US Army is still 156 aircraft short of its requirement for 507 armed OH-58Ds. Both OH-58D sub-variants are rebuilds of earlier OH-58A/C scout helicopters, adding mast-mounted sight and sensors. When rebuilt, these aircraft receive new serial numbers.

T-45 Goshawk moves closer to service

Although the first operational T-45A Goshawk reached VT-21 'Red Hawks' at NAS Kingsville, Texas, on 27 June 1992, the long-delayed replacement for the Douglas TA-4J Skyhawk will not begin advanced training of naval aviators until mid-1993. Though the T-45A programme suffered numerous delays at various stages, the loss of an aircraft at Edwards AFB, California, last year has not created a further delay, and the US Navy now rates the type as 'on schedule'. Arrangements are being made for VT-21 to train a small number of French pilots slated to fly Aéronavale's Rafale fighter.

The US Navy and McDonnell believe they have resolved a fuel control problem with the Rolls-Royce F405-RR-401 Adour engine on the T-45A. The engine control had been found to have a surge problem at high outside temperatures. When the problem was discovered, the fuel control was derated, providing a slower response time.

The Israeli electronics supplier Elbit will provide multi-function cockpit displays for the T-45A from the 60th aircraft onward.

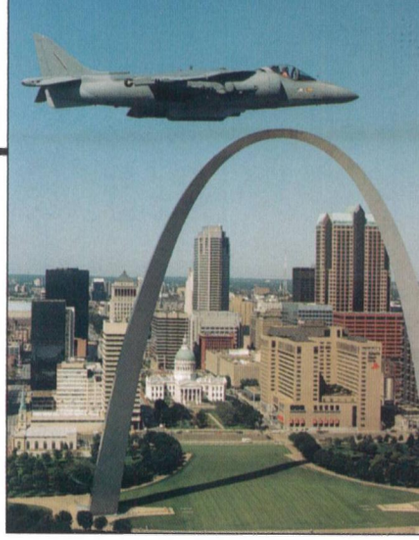
C-130J Hercules 2 closer to production

A December 1992 design review by Lockheed puts the C-130J Hercules 2 airlifter a step closer to production. The current C-130J proposal retains the four-engined configuration of the Hercules rather than the twin-engined layout once contemplated. The new aircraft will be powered by four Allison 2100 turboprop engines driving six-bladed, composite propellers. The Lockheed C-130J Hercules 2, privately funded but responding to a US Air Force statement of need, will have a two-man, automated cockpit with four flat-panel liquid crystal displays, eliminating navigator and flight engineer crew positions. The wing will have no pylons or provision for external tanks, a return to the configuration of the C-130B model of the 1950s which is still viewed as the most fuel-efficient Hercules variant. If a civilian L-100

Once the very backbone of the USAF, the F-4E is virtually out of service following the retirement of the 6512th TS Phantom fleet at Edwards AFB. A handful remain with the 49th FW at Holloman for the training of Luftwaffe crews.

One of the four contenders for the US Army's New Trainer Helicopter (NTH) requirement is the Bell TH206. It is competing against the Eurocopter AStar, Grumman/ Schweizer/UNC TH-330 and Enstrom TH-28.

The second prototype AH-64D made its first flight on 13 November 1992, two weeks ahead of schedule.



Passing St Louis' well-known arch, the AV-8B Harrier II Plus is seen on its first flight, undertaken on 22 September 1992.

variant of the C-130J is also developed, it will include provision for a third crew position to satisfy civil operators. Lockheed does not intend to manufacture a prototype C-130J, but is prepared to deliver a production aircraft in 1996 or 1997.

ATC faces new challenges

In a major shake-up, the US Air Force's Air Training Command (ATC) is taking over progression of pilots from initial screening to near mission-ready status, including late stages of pilot training previously carried out by Air Combat Command (ACC) and Air Mobility Command (AMC).

ATC is taking over two ACC bases, Tyndall AFB, Florida, and Luke AFB, Arizona, and, with them, responsibility for training F-15 Eagle and F-16 Fighting Falcon pilots. AMC's base at Altus AFB, Oklahoma, where C-5 Galaxy and C-141 StarLifter crews are trained, will also be turned over to the training command. This fundamental change in USAF training philosophy takes effect 1 July 1993.

Air Training Command will also take over the following units: 389th Operations Group, Castle AFB, California, which trains KC-135 Stratotanker aircrews; 557th Flying Training Squadron at the US Air Force Academy, Colorado Springs, which operates TG-7 powered gliders and T-41 flight screener training aircraft; 114th Fighter Squadron, Oregon Air National Guard (ANG), at Kingsley Field, which trains pilots on the F-16A Block 15 ADF; 162nd Fighter Group, Arizona ANG, which trains ANG and foreign F-16 fighter pilots; 184th Fighter Group, McConnell AFB, Kansas, which trains Guard pilots in the F-16C/D.

This latter mission, together with the USAF .F-16C/D training function performed at MacDill AFB, Florida, is expected to move eventually to Luke, Arizona. MacDill will remain an ACC base with a combat role. Finally, AT-38B basic fighter transition training is being shifted from Holloman AFB, New Mexico, to existing undergraduate pilot training bases.

In a related training development, protests from rival bidders for the EFS contest were rejected by the US Congress's General Accounting Office and approval was granted on 22 September 1992 to enable Slingsby to proceed in fulfilling its production contract for 113 T-3A Fireflies (company model T67M260s) to replace the T-41. (The latter aircraft was known as the Mescalero when it served with the US Army, but has no USAF nickname.) Slingsby will double its production rate to nine aircraft per month and will increase its work force.

And, in yet another training development, also under ATC purview, Flight Safety International has received a contract for initial and recurrent training for USAF Beech C-12F Huron pilots.

Cessna enters JPATS contest

Cessna has entered the US Air Force/US Navy JPATS (Joint Primary Aircraft Trainer System) competition with a derivative of its newly-certified CitationJet, and becomes the only entrant in the JPATS contest with an 'all American' product. The company's T-tail, twin-engine CitationJet entry is powered by a military version of the Williams FJ44 turbofan and uses a natural laminar-flow (NLF) wing. First flight of the engineering prototype is scheduled for this year [1993].

The JPATS programme, expected to result in a contract award in 1994, will produce 764 primary trainers (down from the 842 once planned), 417 to replace the USAF's Cessna T-37B Tweet (approximately 650 of which still serve in the USAF) and 347 to follow the Navy's Beech T-34C Turbo-Mentor. Just about every company in American aerospace has a stake in JPATS, a $3 billion programme. Six aircraft types, none designed in the US, are being readied for a 1993 Request for Proposals in what has been called, with some exaggeration, the 'trainer sale of the century'.

JPATS began as the US Air Force's PATS programme, its second attempt to replace the ageing T-37B, following cancellation in 1987 of the poorly-managed Fairchild T-46. This second time, the USAF decided to seek an 'off-the-shelf' aircraft rather than risk development of a wholly new aircraft. The Navy came into JPATS belatedly and Air Force and Navy officials worked together to create a December 1988 Memorandum of Understanding on joint trainer procurement.

The services agreed on stepped tandem seating for the JPATS aircraft. The T-37B has side-by-side seating, which permits closer contact between instructor and student during the critical early hours of instruction, but prevents the student from flying the aircraft at its centreline. The Navy T-34C has tandem seating, but the instructor's rear seat is not stepped, or raised. Also specified is an ejection seat. The services have stated no preference for or bias against either a jet or turboprop.

Apart from the Cessna CitationJet, six other contenders are in the JPATS contest: Beech and Switzerland's Pilatus Ltd. with the PC-9 Mk II (Pratt & Whitney PT6A-62 turboprop); Grumman and Italy's Gruppo Agusta with the SIAI Marchetti S.211 (Pratt & Whitney JT15D-5C turbofan); Vought and Argentina's FMA (Fabrica Militar de Aviones) with the IA-63 Pampa 2000 (Garrett TFE731-2-2B turbofan); Lockheed and Italy's Aermacchi with the Italian M.B.339A T-Bird II (Rolls-Royce RB582-01 turbojet); Northrop and Brazil's EMBRAER with the EMB-312H Super Tucano (Pratt & Whitney PT6A-68 turboprop); and Rockwell and Germany's MBB (Messerschmitt-Bölkow-Blohm) with the German FanRanger (Pratt & Whitney JT15D-4 turbofan).

It should be noted that JPATS is indeed a 'system' and not just an airplane; also involved is a GBTS (Ground-Based Training System) which includes aircraft flight simulators, cockpit procedure trainers, courseware, technical data, and computer-based training.

JPATS also offers sales potential to firms which manufacture egress systems. It is understood that any of three ejection seat makers may be chosen for the winning aircraft. The Fan-Ranger and Pampa demonstrator have US-made UPCO seats, though Vought has not made a final decision on what it plans to offer in a production aircraft. US-made McDonnell Douglas ACES II seats are expected to appear on some of the candidates, while the remainder offer British-origin Martin-Baker seats.

U-2R assignment changes in Europe

The 95th Reconnaissance Squadron at Alconbury reduced its complement to just two U-2R aircraft during October. The squadron was originally scheduled to operate in excess of a dozen TR-1As (designation changed to U-2R in December 1991) with assignment to the 17th RW. However, the elimination of the threat from the Warsaw Pact, combined with the withdrawal of Soviet troops from eastern European soil, has negated the requirement for such a large battlefield surveilance system. The number of aircraft in residence was gradually cut, although operations in the Middle East during Desert Shield, Desert Storm and during subsequent months accounted for some of these. The parent wing was inactivated in 1991 with the 95th RS being reassigned to the 9th SRW at Beale AFB, California. The complement was cut initially to half a

Long after the retirement of the EA-3B, the US Navy again has a seagoing Sigint platform in the form of the ES-3A Viking. The Atlantic Fleet squadron is VQ-6 'Black Ravens', based at NAS Cecil Field in Florida.

F-16 Block 50 production continues apace, the first of these aircraft seen taking off from Fort Worth (above). Among recent units to convert to the F-16C are the Iowa ANG's 174th FS (ex A-7D/K), complete with striking bat markings (right) for Sioux ('Gotham') City.

dozen aircraft, with the eventual goal of just four U-2Rs. A change of plan resulted in even this figure being reduced with three aircraft departing Alconbury on 19 and 21 October, to leave only two U-2s to perform the much reduced role. It is quite likely the 95th RS will be inactivated and replaced by a detachment to co-ordinate operations.

Air Mobility Command change of responsibilities

In a change of plan, Air Mobility Command (AMC) agreed to the transfer of overseas-based aeromedical airlift squadrons to local theatre commanders with effect from 1 October. AMC has retained responsibility for the 11th ALS at Scott AFB, Illinois, with assignment to the 375th Airlift Wing, while the 20th ALS at Yokota AB, Japan, and the 55th ALS at Rhein-Main AB, Germany, were transferred to PACAF and USAFE control, joining the 316th Airlift Group and 435th Airlift Wing respectively. All three squadrons operate the C-9A Nightingale. Consideration is being given to the relocation of the 55th ALS to Ramstein AB when the major USAF hospital at Wiesbaden closes in 1993. Should this transfer become reality, the C-9As of the 55th ALS would be reassigned to the 86th Wing.

Second X-29 aircraft placed in storage

The no. 2 Grumman X-29 research aircraft was placed in flyable storage at NASA's Ames-Dryden facility, Edwards AFB, California, following a demonstration flight on 18 October 1992 which closed out the test programme as originally conceived. The no. 1 X-29 was already in flyable storage following a test programme which began in December 1984, during which the two aircraft made more than 450 test flights.

NASA, the Defense Advanced Research Projects Agency, and the US Air Force are interested in reviving flight research with the two X-29s if funding can be obtained. Under consideration are tests firing AIM-9 Sidewinder missiles from the aircraft during high AOA flight to determine the effects on aircraft systems and controllability.

Additional Air National Guard tanker units

The Air National Guard is assuming greater responsibility for the provision of air refuelling with two more squadrons preparing to switch to the tanker role. The 173rd RS/Nebraska ANG at Lincoln MAP and the 196th RS/California ANG at March AFB are due to exchange their RF-4Cs for the KC-135R in 1994 and the KC-135E in 1993 respectively. Once operational with the new role, the Air National Guard will have 19 tanker squadrons, with the following 16 already performing this role:

108th ARS	Illinois ANG	KC-135E
116th ARS	Washington ANG	KC-135E
117th ARS	Kansas ANG	KC-135E
126th ARS	Wisconsin ANG	KC-135R
132nd ARS	Maine ANG	KC-135E
133rd ARS	New Hampshire ANG	KC-135E
141st ARS	New Jersey ANG	KC-135E
145th ARS	Ohio ANG	KC-135R
146th ARS	Pennsylvania ANG	KC-135E
147th ARS	Pennsylvania ANG	KC-135E
150th ARS	New Jersey ANG	KC-135E
151st ARS	Tennessee ANG	KC-135E
153rd ARS	Mississippi ANG	KC-135R
168th ARS	Alaska ANG	KC-135D/E
191st ARS	Utah ANG	KC-135E
197th ARS	Arizona ANG	KC-135E

In addition, the 166th ARS/Ohio ANG is in the process of re-equipping with the KC-135R from the A-7D. As the above list indicates, the majority operate the KC-135E although the KC-135R is gradually making a presence within the Air National Guard, with the Ohio and Wisconsin squadrons having already upgraded to the latter version. The latest unit to convert to the tanker role, the Mississippi ANG, was to have transitioned from the RF-4C to the KC-135E but received the KC-135R model in a change of plan. Additional existing ANG air refuelling squadrons will receive the KC-135R in due course, although the reserves are somewhat reluctant to switch to the variant as the General Electric F108-CF-100 engines lack thrust reversal facilities which are fitted to the JT3D turbofan powerplants of the KC-135E.

F-16D downs Iraqi jet

On 27 December 1992 a General Dynamics F-16D (Block 42) scored the USAF Fighting Falcon's first kill, and in doing so also notched up the first combat success for the AIM-120 AMRAAM missile. Early on 27 December a pair of Iraqi air force fighters penetrated the southern 'No-Fly Zone' but turned back after being challenged by a pair of 1st TFW McDonnell Douglas F-15C Eagles being controlled by an E-3C Sentry.

At 0720 GMT a second pair of Iraqi fighters (thought to be MiG-25s) crossed into the exclusion zone, and was challenged by a pair of F-16Ds from the 33rd Fighter Squadron, 363rd Fighter Wing, from Shaw AFB, but apparently operating from Al Dhafra air base in Sharjah (part of the United Arab Emirates). The Iraqi fighters retreated as the F-16s approached, but a second pair (again thought to have been MiG-25s, but also reported as MiG-29s), which penetrated the exclusion zone at 0740 GMT, ignored radio calls to leave the area and instead turned into the F-16s. Under the rules of engagement then in force, this was interpreted as a hostile act. The lead F-16 (90-0778), piloted by Lieutenant Colonel Gary North, commander 33rd FS/363rd FW, fired an AIM-120 at the lead Iraqi fighter (now 20 nm or 23 miles/37 km inside the exclusion zone) from beyond visual range. The lead Iraqi aircraft was destroyed and his wingman returned to Iraqi airspace.

An Iraqi SAR helicopter was allowed to comb the area for the pilot of the downed aircraft without interference by US fighters, but two fighters which breached the zone the following day were turned back. Following the shootdown, USS *Kitty Hawk* returned to the Persian Gulf from Somalia, where it had been supporting the US intervention. One of its two squadrons of Grumman F-14 Tomcats and one squadron of F/A-18 Hornets were flown off to Dhahran AB in Saudi Arabia on 28 December to reinforce US fighters protecting the exclusion zone, and additional KC-10 Extender tankers and RC-135 Elint aircraft were also deployed.

The shootdown proved to be the opening shot of a round of hostilities by coalition air forces, involving air attacks by US, UK and French aircraft, cruise missile attacks and further shootdowns. Full details will be provided in the next volume.

KC-135s retired to AM&RC

In recent years the KC-135 Stratotanker has been the subject of a much needed modification programme to replace the elderly J57 jet engines with fuel-efficient turbo fan powerplants. Apart from reducing fuel consumption and enhancing the capabilities of the tanker fleet, the modifications will extend the aircrafts' service lives well into the next century. Not all the KC-135s are to be re-engined and some elderly aircraft have begun to be retired from service during the summer of 1992 to be stored with the Aerospace Maintenance & Regeneration Center (AM&RC) at Davis-Monthan AFB, Arizona. Up to 90 C-135s of various types will be stored, including KC-135As and several versions of the EC-135. It is quite likely early production KC-135As will be the major tanker variant to be placed in storage, although this may be only a temporary measure pending more funding for the KC-135R programme (with 397 examples budgeted to date). In addition, some aircraft will find a second lease of life with export customers including Turkey, which has expressed an interest in acquiring three tanker aircraft.

Of the aircraft in store half are KC-135 tankers, while the remainder are former airborne command posts which served with SAC, USAFE, PACAF and TAC. The retirement of the latter types from service was brought about by the elimination of the role. Some may find a new career at some point, although most will eventually be sold or scrapped.

These are not the first C-135s to be placed in storage at Davis-Monthan AFB, as two WC-135Bs (61-2668 and 61-2669) and an RC-135A (63-8060) were short-term inmates during 1972 before returning to service the following year. The first example to be stored and eventually scrapped was KC-135A 55-3126 which served as the original 'Speckled Trout', the personal transport for the Commander-in-Chief of the Air Force. 53126 arrived for storage on 31 July 1975 and had much of its internal equipment removed for installation on the new 'Speckled Trout' 61-2669. Other parts from 53126 were salvaged, including the cockpit which was obtained by Boeing to support various programmes, and is still located at the Wichita, Kansas, facility. In addition, part of the right wing was employed by Boeing Wichita as a mock-up for the CFM56/F-108 engine programme. The wingtips from 53126 were used aboard 55-3129 for the winglet programme when the latter aircraft was an NKC-135A with Air Force Systems Command. The French air force is believed to have acquired the vertical stabiliser section from 53126 for training purposes.

AM&RC (formerly MASDC) records show the departure date as 4 May 1979, although this is likely to have been little more than removal from the inventory. These records show the aircraft as being assigned to the Department of Energy at Mercury, Nevada. Their interest in the airframe was for the carriage of radioactive material in a special container and for the aircraft to be destroyed in a ground experiment to test the integrity of the receptacle. The DoE did not proceed with the acquisition of this particular aircraft and the car-

cass was eventually scrapped.

The second aircraft to be stored was NC-135A 60-0370, which was flown to Davis-Monthan AFB on 30 June 1976 after serving with the Air Force Special Weapons Center at Kirtland AFB, New Mexico. The aircraft was one of three which circumnavigated nuclear tests to photograph the explosion and monitor the fallout and radioactivity. During its years in storage the aircraft has had the majority of its parts removed and is still located in AM&RC, although barely recognisable as a C-135. EC-135H 61-0291 arrived from Mildenhall on 30 May 1991 after serving with the 513th ACCW and has been methodically dismantled to determine the extent of corrosion damage.

C-135 Stratotankers stored at AM&RC October 1992

KC-135	56-3594, 56-3603, 56-3608, 56-3615, 56-3634, 56-3635, 56-3636, 56-3637, 56-3644, 56-3646, 56-3647, 56-3651, 57-1420, 57-1467, 57-1476, 57-1477, 57-2590, 58-0033 all ex SAC
KC-135D	63-8059 ex 168th ARG/Alaska ANG
EC-135A	61-0278, 61-0289, 61-0297 all ex 28th BW/SAC
EC-135C	62-3583, 63-8051 both ex 55th SRW/SAC
EC-135G	62-3570, 62-3579, 63-8001 all ex 28th BW/SAC 63-7994 ex 305th ARW/SAC
EC-135H	61-0285 ex 513th ACCW/USAFE
EC-135J	63-8056 ex 15th ABW/PACAF
EC-135L	61-0261, 61-0263, 61-0279, 61-0283 all ex 305th ARW/SAC
EC-135P	55-3129, 58-0019, 58-0022, 61-0274 all ex 1st TFW/TAC
NKC-135A	55-3127 ex 4950th TF/AFSC

Note: the Commands shown are those which operated the type prior to the reorganisation of the Air Force in June 1992. Some of the KC-135As were briefly in service with ACC and display the 'DY' tailcode of the 96th Wing, while others were with AMC.

US Navy and Marine Corps squadron news

In recent months the US Navy and Marine Corps have disestablished or relocated a number of squadrons as part of their ongoing 'draw down' process. As part of the removal of US forces from the Philippines, VC-5 tailcode 'UE' was disestablished on 31 August, having retired or redistributed its A-4E, TA-4J and SH-3G to other squadrons. One month later a second Pacific Fleet composite squadron was disestablished when VC-1, tailcode 'UA' at NAS Barbers Point, Hawaii, ceased operating on 30 September. At NS Mayport, Florida, HSL-36 (tailcode 'HY') lost its SH-2F Seasprites prior to the squadron disbanding on 30 September.

As part of the retirement of squadrons assigned to Carrier Air Wing 6, deployed aboard CV-59/USS *Forrestal* prior to withdrawal of the ship, VS-28 was disestablished at NAS Cecil Field, Florida, on 1 October with its S-3Bs being reassigned. The same fate befell VA-176 at NAS Oceana, Virginia, on the same date with their A-6Es and KA-6Ds also joining other squadrons. A third squadron from CVW-6 which was to have been discontinued on 1 October has received a reprieve. VAW-122 has been given a two-year service extension at NAS Norfolk, Virginia, to perform special missions including drug interdiction duties under Carrier Early Warning Wing Twelve although the squadron will be available for carrier deployment if required.

Within Naval Training Command, Training Wing Three (TW-3) at NAS Chase Field, Florida, was disestablished on 31 August, with its two squadrons, VT-24 and VT-25, both equipped with the TA-4J following the same fate on 18 September. The station is due to close on 2 April 1993. At nearby NAS Kingsville the first T-45A Goshawk squadron became operational with Training Wing 2 (TW-2) on 27 June when VT-21 completed conversion and commenced their first course.

At NAS Miramar, California, VF-24 and VF-211 have both reverted back to the F-14A from the F-14B model during the summer of 1992 as insufficient numbers of the latter version of the Tomcat are available to sustain six fleet and two training squadrons. The Naval Fighter Weapons School (NFWS), better known as 'Top Gun' and VF-126, both at NAS Miramar, have completed replacing their A-4E and F models of the Skyhawk with the A-4M version obtained from disbanding Marine Corps Reserve squadrons. The final carrier deployment by an ASW squadron equipped with the S-3A version of the Viking commenced on 1 August when VS-38 departed, North Island, California, aboard CV-61/USS *Ranger* on the ships final WestPac cruise. Along the coast at NAS Alameda, HS-85 (tailcode 'NW') completed conversion from the SH-3D to the SH-3H during the summer, thereby ending the ASW operational career of the former model of the Sea King.

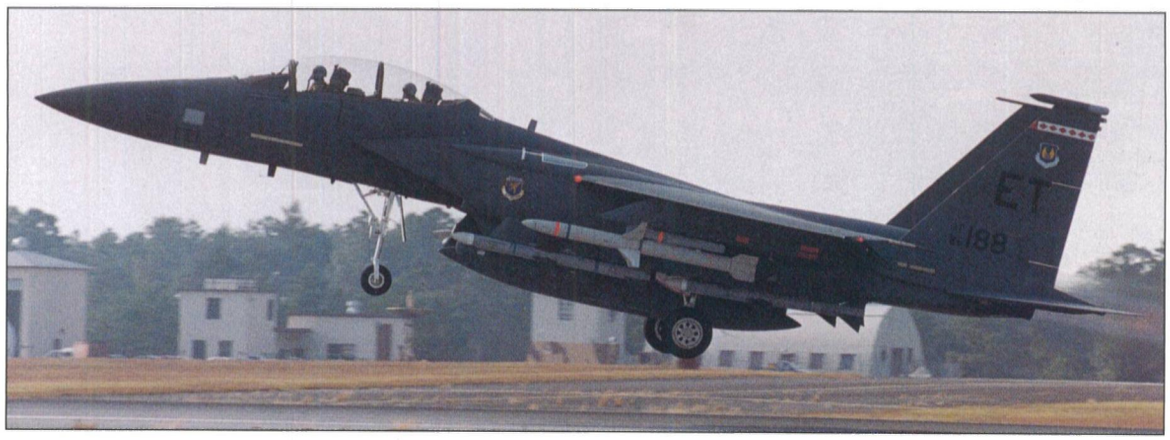
The consolidation of both E-6A Mercury TACAMO squadrons at Tinker AFB, Oklahoma, within Strategic Communications Wing One, which was formed on 1 May, was midway through completion during September when VQ-3 moved from NAS Barbers Point, Hawaii. Sister squadron VQ-4 from NAS Patuxent River, Maryland, was expected to complete its move by January 1993.

Within the Marine Corps two Reserve squadrons were disestablished recently. VMA-322 (tailcode 'QR') at NAS South Weymouth, Massachusetts, was disbanded on 30 June followed on 30 September by VMA-133 (tailcode 'ME') at NAS Alameda. Both operated the A-4M, which have been transferred to the aggressor role or retired. Expansion of electronic warfare capabilities by the EA-6B Prowlers of the Marine Corps have seen the creation of two additional squadrons joining VMAQ-2. VMAQ-1 (tailcode 'CB') formed on 1 July at MCAS Iwakuni, Japan, although the unit will be home-based at MCAS Cherry Point, North Carolina. VMAQ-3 (tailcode 'MD') was formed on the same day at Cherry Point. A fourth squadron was added on 1 October at Cherry Point when VMAQ-4 (tailcode 'RM') officially formed as a front-line unit. The latter had stood down the previous day at NAS Whidbey Island, Washington, where it was a reservist squadron.

Marine Air Group 13 (MAG-13) at MCAS Yuma, Arizona, moved a stage closer to completing conversion to the night attack variant of the AV-8B during the late summer of 1992, when both VMA-311 and VMA-513 (tailcodes 'WL' and 'WF' respectively) began receiving this version of the Harrier II. HMM-262 (tailcode 'ET') relocated from MCAS Kaneohe Bay, Hawaii, with their CH-46Es to MCAS Futemma, Japan, during the summer to help alleviate the strain on Marine Corps medium helicopter squadrons deploying to the Far East. Closer to home HMH-462 (tailcode 'YF') at MCAS Tustin, California, retired the last two CH-53A versions of the Sea Stallion from Marine Corps service on 16 July.

Right: Seen undergoing avionics tests in an anechoic chamber is the first of three FSD aircraft for the A-6E Block 1-A upgrade programme. The aircraft first flew on 30 September 1992, and features numerous improvements, including modified wing fillet, head-up display for the pilot and extra fuel capability.

The 3246th TW at Eglin began captive carry tests of the AGM-88 HARM on an F-15E on 27 October.



Adoption of mid-grey all-over camouflage and TAC-style serial presentation and tailcodes has given the B-1B fleet a new look. The 'GF' code is for the 319th Bomb Wing at Grand Forks.

SARAJEVO Air Bridge Lifeline

At the end of 1992, the crisis in the former Yugoslav republic of Bosnia-Herzegovina was deepening. Fighting continued unabated, and the onset of winter made the airlift of relief aid to the population ever more vital. Here we review the story of the airlift, which began in July and still continued at the end of the year.

The view from a C-130 on approach to Sarajevo's Butmir airport. 'Khe Sanh' tactical approaches are the norm to keep the danger from SAMs and AAA to the minimum. Serbian positions surround much of the airfield.

A massive multinational airlift to supply Sarajevo's 400,000 beleaguered residents with much-needed food and medical supplies began in the first week of July as the Bosnian civil war escalated. The airlift came to an abrupt halt in the first week of September when an Italian Air Force G222 was shot down near Sarajevo. After a month-long halt the United States Air Force re-opened a precarious air bridge to the Bosnian capital in a bid to protect the city's population from the privations of winter.

During July and August on average some 20 flights a day were being made into the city's single-runway airport, which had been secured in early July by troops of the United Nation's Protection Force (UNPROFOR), under the command of Major General Lewis MacKenzie. At regular intervals the UN have had to close the airport and wave off incoming relief flights after

Among the first aircraft into Saravejo were the RAF Hercules C.Mk 1P transports of No. 47 Sqn's Special Forces flight. XV206 was a Sarajevo regular, this aircraft featuring Orange Blossom ESM equipment on the wingtips.

Sarajevo scenes: Blue-helmeted UN ground crew work hard to quickly offload an Air Mobility Command C-130 (left), so that it can be airborne again in a matter of minutes, while a French Transall unloads in front of the terminal building (above). The airport buildings have received damage during mortar attacks, but the tower (right) is still functioning under United Nations control.

outbreaks of fighting between Serbian and Bosnian forces near the airport. On occasion, the UN positions at the airport have also been attacked by Serbian artillery.

The United Nations airlift began in July after the daring flight into the Bosnian capital on a French air force Dauphin helicopter, of ET 60 GLAM, by French President François Mitterand on 28 June. An escorting Super Puma helicopter was temporarily abandoned at Sarajevo after being hit by sniper fire. It was later flown out to Split by a French C-130H. The president's Falcon 900 jet was flown into Sarajevo but could not be used to fly him out after it was damaged in a collision with an airport vehicle. Two French air force C.160 Transall transport planes arrived the following day with some 13 tons of medical supplies, breaking the two-month siege of Sarajevo. They had tried to land at Sarajevo on the previous day but had been waved off because of heavy fighting. French army aviation personnel then set about restoring the war-ravaged airport's facilities to allow the main airlift to start later in the week.

Ground protection

On 1 July a guard force of 125 French marine infantry was flown in by C.160s to provide defence until the UN's Canadian infantry battalion with their M113 APCs could complete the overland journey from Croatia three days later. French air force C-130H Hercules of ET 2/61 also joined the relief operation on this day. A Norwegian C-130 touched down at Sarajevo on 2 July as the international airlift effort began to gather momentum. On 3 July the first USAF C-130E Hercules relief flight arrived with 1,200 lb (545 kg) of EC food and two forklifts to help speed the unloading of supplies by future aircraft. Using the codename Operation Provide Promise, the USAF aircraft of the 435th Airlift Wing flew out of their home base at Rhein-Main air base, near Frankfurt, Germany. An RAF Hercules, of No. 47 Squadron's Special Forces Flight, also flew into Sarajevo with some 3,000 British Army ration packs, after staging through the Croatian capital Zagreb on the previous day. The British relief flights took place under the codename Operation Cheshire.

An RAF BAe HS 125, of No. 32 Squadron, flew into Sarajevo later in the day carring the European Community peace envoy Lord Carrington on yet another of his futile efforts to negotiate a ceasefire.

Within two days more nations had assigned aircraft to the airlift effort. Spain, Greece, Saudi Arabia, Italy (50° Gruppo TM), Denmark, Canada and Belgium (15th Transport Wing) provided more C-130s, while France, Germany and Turkey sent C.160 Transalls to join the effort. Italian G222s operated by 2° and 98° Gruppo TM were also regular visitors to Sarajevo. Ukrainian An-32 'Clines' assigned to UNPROFOR in Croatia have flown missions to Sarajevo, painted in UN colours and carrying politicians and UN military commanders, and evacuating wounded.

UN control

The air bridge to Sarajevo is co-ordinated by UN personnel in Sarajevo and Zagreb. In the first weeks of July the Canadians with their M113 APCs secured Sarajevo airport and distributed supplies to the residents of the besieged city but, by the end of July, they had largely been replaced by a new UN force of French, Ukrainian and Egyptian soldiers.

Belgium's C-130 force joined the airlift at an early stage with aircraft from 20 Smaldeel.

Above: In addition to active-duty USAF aircraft, C-130s from the ANG and AFRES (illustrated) fly regularly on the airlift. The C-130 is far less vulnerable than the C-141 or C-5.

The airport operation was run by a multi-national team of personnel drawn from a variety of countries including Britain, France, USA, Denmark, Poland and Canada. By the end of July some 200 tons of supplies were being delivered each day to Sarajevo, although UN chiefs said that this was only enough for temporary relief and large truck conveys were needed.

Zagreb was the forward staging base for the airlift operation and the site of a major stockpile of food and medical supplies. Most aircraft taking part in the airlift took off from their home bases, delivered their initial load of supplies to Sarajevo and then staged through Zagreb, where they would pick up an extra load of supplies and then make the short hop back to Sarajevo, before returning back home by night fall. A multi-national team at Zagreb, including Canadians and Germans, loaded up the transports as they arrived empty from Sarajevo. French and Italian aircraft also made regular use of the Croatian-controlled airport at Split on the Dalmatian coast.

Planning for the airlift began in June with US European Command and the United Nations High Commission for Refugees working together to stockpile supplies in Zagreb, to be flown to Sarajevo airport when it had been secured by UN troops. The summer airlift was not the first time USAF aircraft had flown relief supplies into Sarajevo; five C-141B StarLifter missions had been made to the city before the siege began in earnest. C-5A/B Galaxies and C-141Bs were not used on the summer airlift because the UN troops at Sarajevo did not have the cargo handling capability to quickly turn around the giant American transports.

Above: Ukraine forces provided An-32 'Clines' for the UNPROFOR in Croatia, and these are regular Sarajevo visitors.

VIP jets are common sights, bringing in politicians attempting to find a way to end the civil war. This is an Italian Falcon 50.

The shuttle of aircraft was increasingly used to bring out refugees, casualties and UN personnel from Sarajevo. It also allowed the rapid transit of key items of equipment and UN personnel into the Bosnia capital. Many aircrews dipped into their own pockets to buy newspapers, crates of soft drinks and chocolates and then delivered them to the UN troops.

Self-defence

Transport aircraft flying into Sarajevo adopted fully tactical flight profiles because of the threat from Serbian surface-to-air missiles (SAMs) and anti-aircraft artillery (Triple A). Typically, they approached the city from the west because the dash from the Dalmatian coast near the port of Split reduced to the absolute minimum the time they had to be over Serb-controlled territory. UN controllers in Sarajevo gave inbound flights the final 'go/no-go' to proceed to the Bosnian capital as they crossed the coast at Split.

The final approach to Sarajevo owed much to tactics developed during the Vietnam War, when USAF C-130s were used to fly supplies into besieged jungle fire bases. Indeed, the tactic is termed a 'Khe Sanh landing' after the Vietnam War battle. To keep out of SAM and Triple A range aircraft stayed at medium altitude until the last possible minute, then turned into a tight 'corkscrew' dive to bring them to the end of the airport runway.

Speedy turn-round

Once on the ground a fast turn-around using forklifts was carried out to unload the palletised cargoes of the transport aircraft. UN armoured vehicles then escorted truck convoys down 'sniper alley' into the city centre. UN personnel have perfected their unloading to such an extent that they were able to turn around a C-130 in as little as seven minutes, although the average was around 15 to 20 minutes.

The first USAF aircraft to fly into Sarajevo were drawn from the 37th Airlift Squadron (ALS) which is normally based at Rhein-Main. The squadron's commander Lieutenant Colonel Larry Radov was designated mission commander for the American operation. During the first two months of Provide Promise, USAF C-130s flew 172 sorties and delivered some 2,195 US tons of food and supplies to Sarajevo.

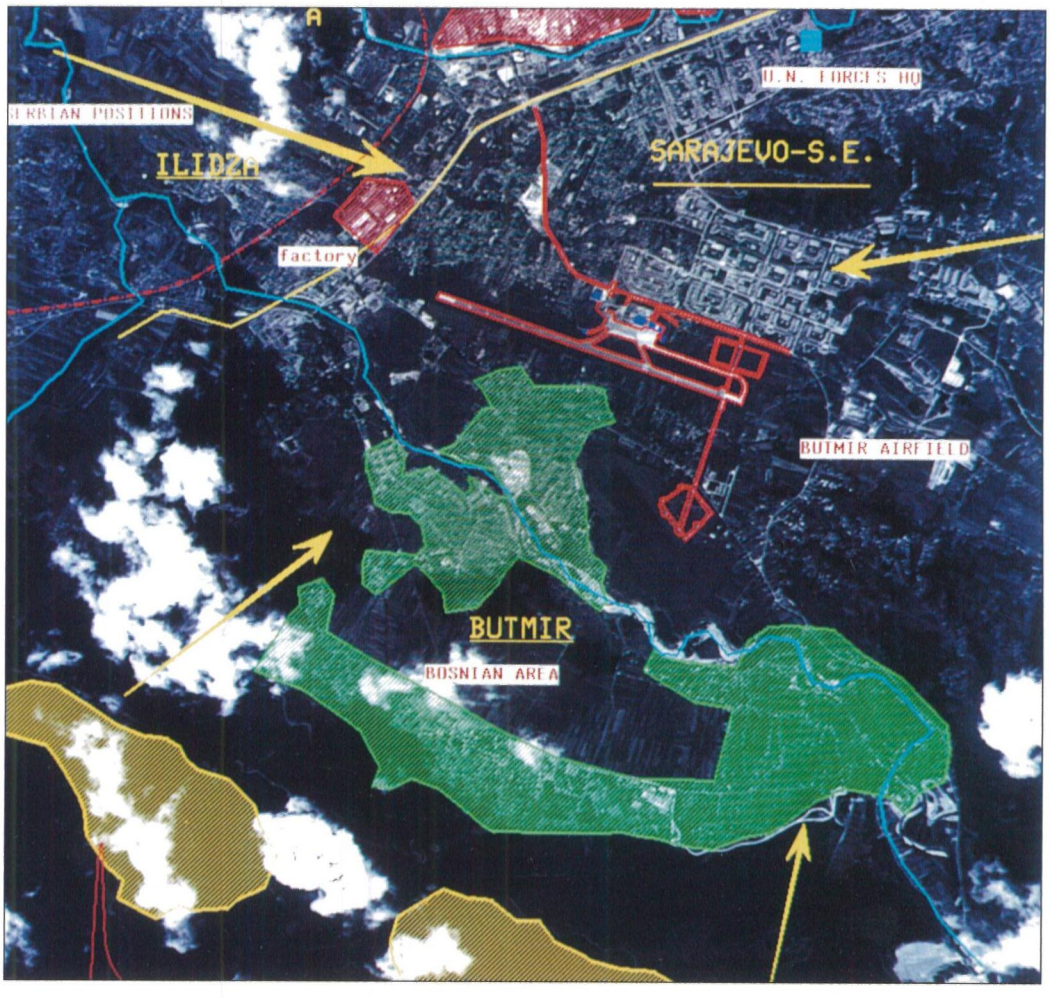
The 37th ALS's C-130Es lack SAM missile countermeasures, such as flare/chaff dispensers, so after the early American relief flights were 'painted' by Serbian SAM radars the USAF decided to draft in countermeasures-equipped aircraft from the continental USA, including USAF Reserve and Air National Guard machines. British and Canadian aircraft taking part in the airlift were also protected by countermeasures. RAF aircraft were fitted with AN/ALQ-157 IR jammers and AN/ALE-40 chaff/flare dispensers.

In the first two months of the airlift no participating aircraft were seriously damaged by fire. The only hits recorded were against a French C.160, which was struck by a stray small arms round on 12 July, and an RAF Hercules which, on 3 July, picked up two dents from bullets. In both cases only minimal damage was caused.

On a number of occasions the airport has come under fire and had to be closed. On 20 July Canadian, Belgian and Italian aircraft were waved off landing after the worst fighting for two weeks broke out in Sarajevo, with mortar and machine-gun fire hitting the airport. A further 20 flights were cancelled and the aircraft had to wait at Zagreb until the situation stabilised. The airport reopened on 22 July. A Turkish C.160 made the first paradrop of supplies into Sarajevo on 30 July. In early August the airport

Among the airlift aircraft best-protected against missiles are the Hercules of the RAF. However, there is little defence against gunfire, and one was hit, thankfully with little damage.

Taken from a Hercules approaching the airport (centre right), this photo shows Sarajevo city (centre left), a puff of smoke marking an artillery attack. The SPOT satellite image from September (right) shows the location of the airport, Bosnian positions, and the main directions of Serbian artillery fire (yellow arrows).



was closed for four days after heavy fire was directed at UN forces there on 4 August.

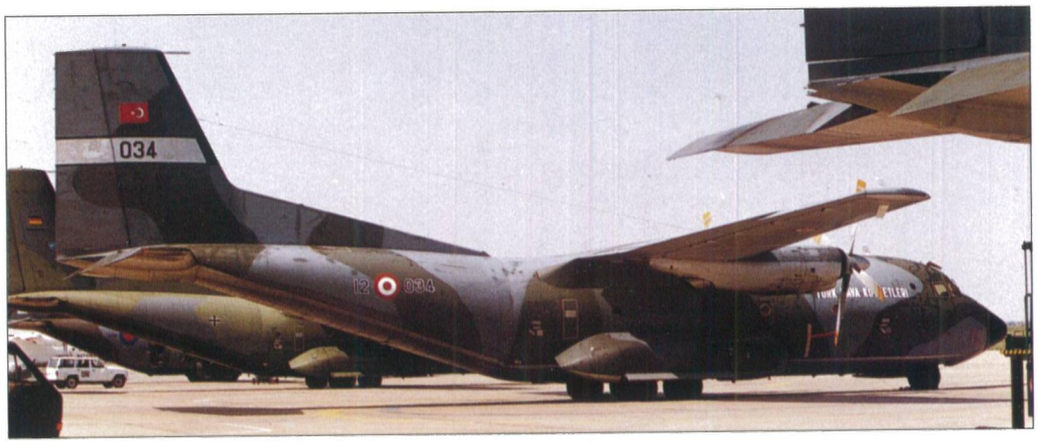
Throughout July Western governments started to move naval forces into the Adriatic to enforce UN sanctions against Serbia. American naval forces in the Adriatic Sea included the Mediterranean Amphibious Ready Group (Task Force 61), which boasted a full US Marine Corps Expeditionary Unit – Special Operations Capable (MEU(SOC)) with some 800 combat troops. The 26th MEU(SOC), based aboard the USS *Iwo Jima*, had its own integrated helicopters, including 12 CH-46E Sea Knight and four CH-53E Super Stallion assault helicopters, three UH-1N utility helicopters and four AH-1W Cobra helicopter gunships. Also part of the Task Force 61 were the amphibious landing ships USS *Trenton*, USS *Tortuga*, USS *Saginaw* and USS *Spartanburg County*. The cruiser USS *Biddle* was the force guard ship in the Adriatic.

Sanction monitoring

In mid-July NATO sent its Standing Naval Force Mediterranean to the Adriatic to help monitor UN sanctions against Serbia and its ally Montenegro. Ships assigned to the force included the German destroyer FGS *Bayern*, the Italian frigate ITS *Alieso*, the Greek destroyer HS *Sachtours*, the Dutch frigate HNLMS *Pieter Florisz*, the Turkish frigate TCG *Turgutrels*, the Spanish frigate SPS *Beleares*, the USS *Jack Williams* and HMS *Avenger*. A US Navy P-3 Orion aircraft based at NAS Sigonella supported the maritime interception force, along with Dutch Orions, German and French Atlantic, and Greek Albatross maritime patrol aircraft. Italian Atlantics also supported this effort.

France wanted to send a squadron of four Gazelle helicopter gunships and five Puma transport helicopters to support the UN force in Sarajevo in mid-July, but after consultation with its allies the French kept the helicopters on ships in the Adriatic.

Fixed-wing aircraft available to US commanders include F-14A Tomcat fighters, F/A-18 Hornet strike fighters and A-6E bombers deployed on the USS *Saratoga* of the US Sixth Fleet. The carrier was only a few days sailing from Yugoslavia and on hand to provide combat air patrols to protect the United Nations airbridge to Sarajevo.



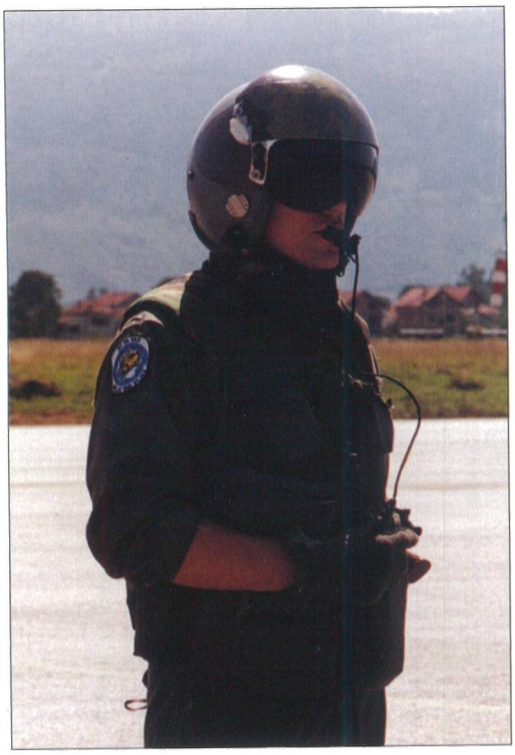
With Germany (above), France (below) and Turkey (left) heavily involved in the airlift of supplies, the Transall C.160 is a mainstay of the airlift effort. France also uses its Hercules fleet.

Airborne early warning and control for the NATO maritime intercept force operating in the Adriatic was provided by E-3A Sentries of the NATO AWACS force from their home base in Germany and forward bases at Triponi, Italy, and Preveza, Greece. The NATO E-3s took turns to fly surveillance missions over the Adriatic with RAF E-3Ds and French E-3Fs, the latter often flying from their home base and the British AWACS forward base in Italy. The surveillance operation continued throughout the summer and into the autumn, with early warning of Serbian and Croatian air activity being passed to UN transport aircraft flying into Sarajevo.

The need for these powerful aircraft was demonstrated on 11 and 12 July when Serb-piloted Yugoslav Air Force aircraft flew a reconnaissance mission against US ships in the Adriatic. The Yugoslav pilots jammed the USS *Biddle*'s radar before turning for home.

Under fire

On 19 August the airbridge to Sarajevo was halted when an RAF Hercules was fired on by a Serb radar-guided 20-mm anti-aircraft gun as it was taking off from the city's airport. To avoid the threat the crew popped their flares and chaff. Two days later the airport was re-opened but heavy fighting broke out in Sarajevo, with UN positions coming under heavy attack. The airport had to be temporarily closed for a time on 23 August. In the run-up to the London Peace Conference on 26 August fighting became more intense and BBC reporter Martin Bell was injured by shell fire and evacuated from Sarajevo by a Luftwaffe C.160.



Tragedy struck the air bridge on 3 September – just days after the 1,000th airlift sortie had been flown into the city – when an Italian Air Force G222 of 48ª Brigata was hit by a surface-to-air missile on its final approach to Sarajevo from Split. All four crew were killed. When UN personnel at Sarajevo lost contact with the G222 they immediately closed down the airlift. Two USMC AH-1W Cobras and two CH-53Es from the *Iwo Jima* were scrambled to launch a search and rescue mission. As they approached the crash site they were fired on by local Croat fighters who thought the machines were Serb.

To date, the UN commanders have refused to attribute responsibility for the attack on the G222, although the incident took place near a front-line region so any of the three armies fighting in the Bosnian conflict could have fired the missile.

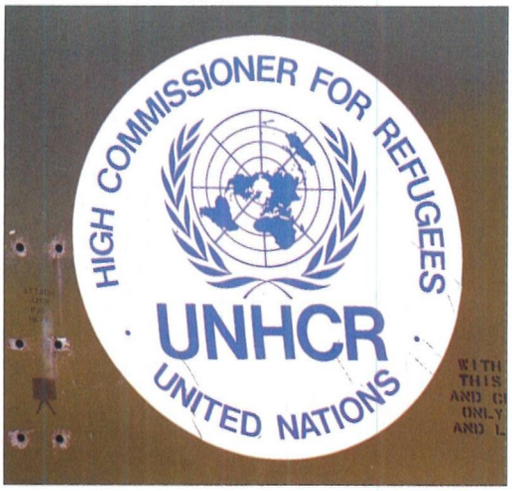
On 14 September the UN Security Council approved the dispatch of an extra 5,000 troops from Britain, France, Canada, Spain and other NATO countries to Bosnia to escort relief convoys. It was expected thay they would not be in place until November.

A loadmaster from the 37th Airlift Squadron supervises the turn-round of his Hercules. Body armour and helmets are essential wear for any personnel flying into the city.

Air bridge re-opens

The United States Air Force opened a precarious air bridge to besieged Sarajevo on 3 October when a West Virginia Air National Guard C-130E touched down at the Bosnian capital's battered airport carrying 10 tons of US military rations. French C.160s and Canadian C-130s soon joined the airlift effort but other Western air forces did not immediately resume flying into Sarajevo because of safety fears after the shooting down of the Italian G222. RAF Hercules joined the new airlift effort on 10 October, with the intention of flying two sorties a day into Sarajevo. Luftwaffe C.160s rejoined the airlift the following week. American and Canadian mobile aerial port personnel also deployed to Zagreb Airport to load relief supplies onto aircraft.

UN relief flights abandoned the direct westerly route into Sarajevo and flew alternative routes to avoid 'high threat' areas. On average, four to seven aircraft a day were landing with relief supplies but UN High Commission for Refugees personnel in Sarajevo say the airlift needed to reach its summer level of 20 flights a day if a human disaster was to be avoided in the city during the winter. Weather conditions over Sarajevo were steadily deteriorating as winter approached. As many as half the scheduled daily UN relief flights were aborted due to low cloud and mist over the city's single-runway airport. To allow the airlift to continue into the winter the UN planned to install a TACAN bad weather



Most air bridge machines wear the badge of the UNHCR.

navigation system in Sarajevo by 14 October, but a number of the six aircraft scheduled to fly in the equipment were prevented by bad weather from landing at the airport.

USAF aircrews flying from Rhein-Main air base, in Germany, said missions to Sarajevo were now more dangerous than tactical airlift sorties during the Gulf War. "We're nearer to the threat," said Captain Jed Scott of the 317th Airlift Wing. The high-risk nature of the air bridge was highlighted on 21 October when the UN closed the operation for 24 hours because of heavy fighting under the flight path near Sarajevo airport. A UN An-32 had been hit by small arms fire near Sarajevo in the early days of the new airlift, and unconfirmed reports suggest a USAF C-130E also attracted a stray round on 10 October.

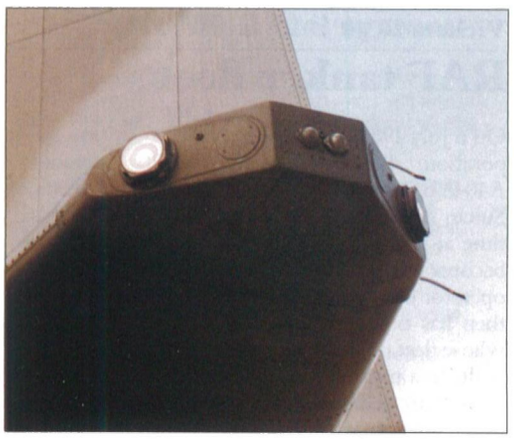
On 9 October the United Nations Security Council voted to ban military flights over Bosnia but no decision has been made yet about how the 'No-Fly Zone' is to be enforced. Flights by Serbian combat aircraft over northern Bosnia on 10 October seemed to be a deliberate attempt to show contempt for the UN. By the end of November, NATO AWACS had monitored

RAF Hercules are fitted with the AN/ALQ-157 infra-red countermeasures turret (above), and AN/ALE-40 chaff/flare dispensers (right).

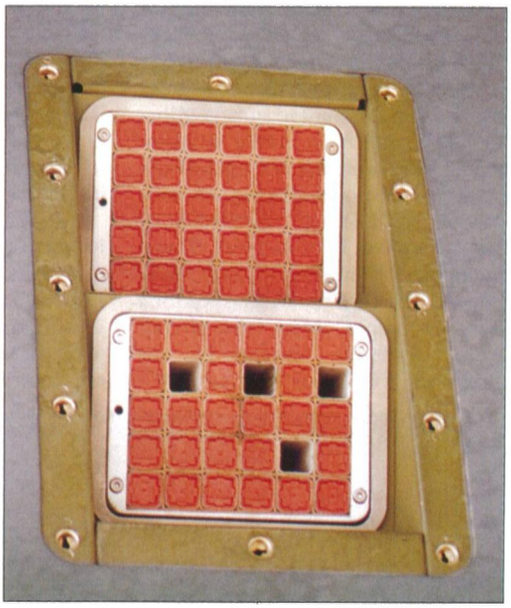
some 100 violations of the UN ban.

AWACS cover was increased on 31 October when Sentries started to fly surveillance missions over Hungary, looking deep into Serbian and Bosnian airspace, under the codename Operation Sky Monitor. The Hungarians were reported to have offered to provide MiG-21 combat air patrols to protect the NATO aircraft, in an unprecedented show of East-West military cooperation.

By late November 1992 UN troops were on the ground in Bosnia in strength and starting to deliver food to the besieged mountain communities. Road conditions were so bad that UN relief planners started to think in terms of extending the air bridge operation from Sarajevo to other



Above: USAF C-130s on the airlift are provided with the AN/AAR-47 missile warning system, with antennas in the tailcone.



parts of the country, using former Yugoslav Air Force air bases, such as Tuzla. As of early December 1992, these plans had yet to be put into action.

Rhein-Main is the main USAF base for the Sarajevo airlift, the resident 37th AS providing much of the logistic support for the US Operation Provide Promise. The ramp groans under the weight of the unit's own aircraft, plus others passing through from stateside units.

BRIEFING

Vickers VC10

RAF tanker fleet

On 6 July 1987, British Aircraft Corporation (Vickers) Super VC10 A40-AB, formerly owned by the Sultan of Oman, landed for the last time at its birthplace, Weybridge, to become a museum exhibit. The only operator of this graceful airliner since then has been the Royal Air Force, whose fleet now numbers 27 of the 54 built. In a process still under way, all of these are being converted to tankers or tanker-transports.

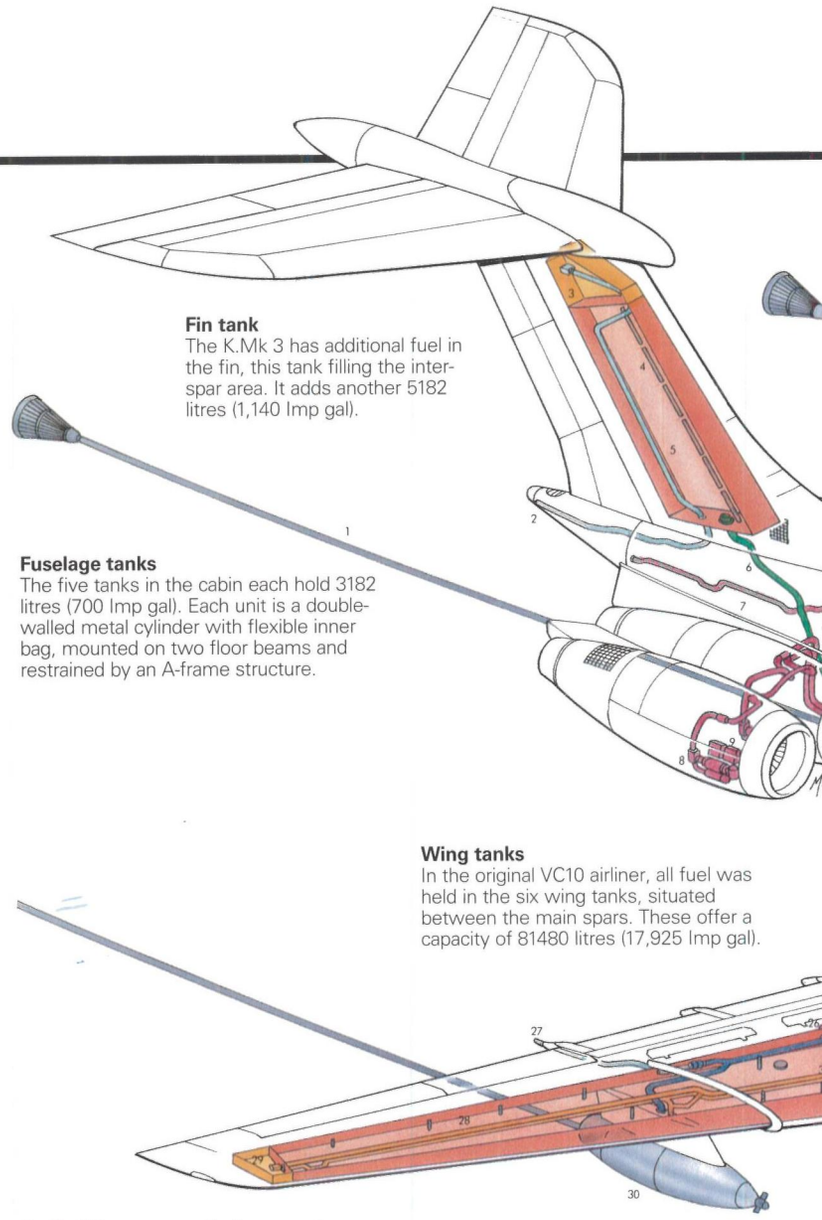
Initial RAF involvement with the VC10 was in the strategic transport role, meeting specification C.239 for an aircraft able to carry 150 troops (or 76 stretchers) for 3,670 miles (5900 km) without recourse to its airborne refuelling capability. An order for five was announced in September 1961, followed by six in 1962 and three in July 1964, a further five options not being taken up. Serials assigned were XR806-XR810 and XV101-XV109 (plus XV110-XV114 unused). Given the BAC type number V1106 (to have been V1105, until the RAF asked for a forward freight door), the aircraft were externally similar to the 'standard' VC10, but had the 1,440-Imp gal (6546-litre) fin fuel tank and uprated Rolls-Royce Conway 301 engines of the Super VC10, plus rearward-facing seats. XR806 first flew on 26 November 1965 and XV109 on 1 August 1968.

Appropriately, No. 10 Squadron formed at Brize Norton on 1 July 1966 to operate the VC10 C.Mk 1 and received XR808 on 7 July as its first aircraft. The squadron flew from Fairford until 23 May 1967, having begun scheduled services in April, and in November 1968 each of the 14 aircraft was named in honour of an aerial winner of the Victoria Cross. XR809 was flown to Rolls-Royce at Hucknall on 17 April 1969 and next took to the air on 6 March 1970 as G-AXLR with an RB211 engine replacing the port pair of Conways. This testbed was retired to No. 5 Maintenance Unit at Kemble in October 1975 and scrapped.

Foreseeing retirement of the Victor K.Mk 2 tanker force, Air Staff Requirement 406 was made public in 1978, calling for a replacement type, to which a VC10 conversion was tendered. British Aerospace secured the contract, then worth some £40 million, in May 1979, for 1982-83 delivery of nine aircraft. These comprised five VC10 K.Mk 2s produced from ex-Gulf Air (originally BOAC) V1101 early-production VC10s and four K.Mk 3s, the last of the type built, which were Series V1154 Super VC10s from East African Airways. The latter had fuselages 13 ft 0 in (3.96 m) longer, were powered by Conway R.Co.43D Mk 550 engines in place of the 'standard' VC10's R.Co.42 Mk 540s, and benefitted from fin fuel storage, as well as many minor modifications brought in during the production run.

RAF moves to standardise its growing VC10 fleet included conversion of all engines to Mk 550B standard – equivalent to the military Mk 301 – and deletion of outboard engine reverse thrust on the Supers, so all aircraft have just inboard reversers. The new machines were also modified with nose refuelling probes and a Turboméca Artouste 520 APU in the tailcone, receiving the revised company designations V1112 VC10 and V1164 Super VC10. The latter also had their forward fuselage freight doors sealed, while the fleet retrospectively gained a crew escape door.

The prospective K.Mk 2s were serialled ZA140-ZA144, and the


Fin tank
The K.Mk 3 has additional fuel in the fin, this tank filling the inter-spar area. It adds another 5182 litres (1,140 Imp gal).
Fuselage tanks
The five tanks in the cabin each hold 3182 litres (700 Imp gal). Each unit is a double-walled metal cylinder with flexible inner bag, mounted on two floor beams and restrained by an A-frame structure.
Wing tanks
In the original VC10 airliner, all fuel was held in the six wing tanks, situated between the main spars. These offer a capacity of 81480 litres (17,925 Imp gal).

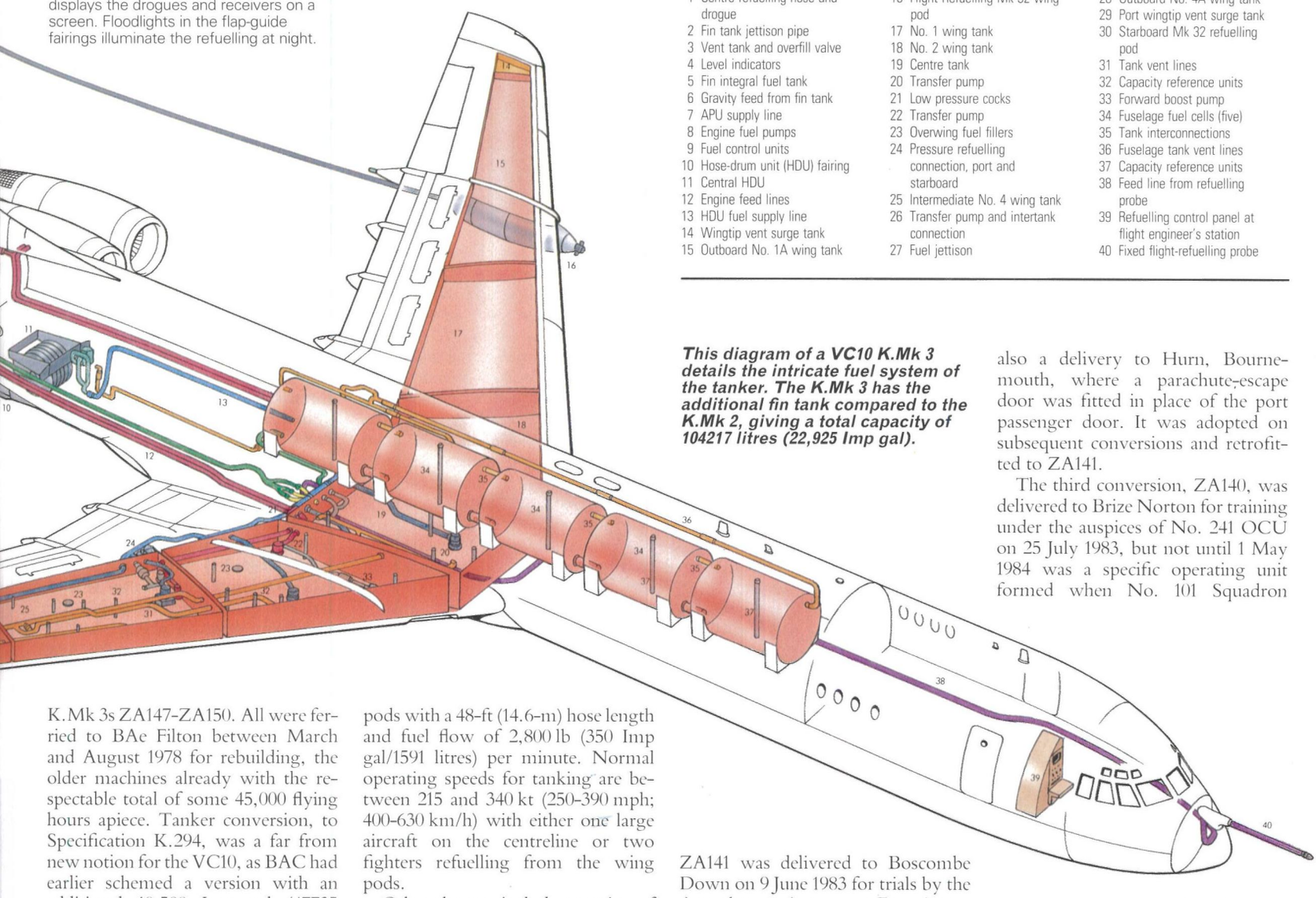
Left: Nine years of storage at Abingdon left their mark on the Super VC10s. Considerable work was required just to get them airworthy for the short hop to Filton. Here they are undergoing conversion to K.Mk 4 standard, similar to the K.Mk 3 but lacking the additional fuselage tanks.

No. 101 Sqn has five K.Mk 2s, based on the short-fuselage VC10. The original wing tankage of the airliner and five new fuselage tanks give a capacity of 97671 litres (21,485 Imp gal).

Fuel control
Control of the internal and offload fuel system is handled by the flight engineer. A turret-mounted TV camera under the belly displays the drogues and receivers on a screen. Floodlights in the flap-guide fairings illuminate the refuelling at night.

British Aerospace VC10 K.Mk 3 fuel system

1 Centre refuelling hose and drogue
2 Fin tank jettison pipe
3 Vent tank and overfill valve
4 Level indicators
5 Fin integral fuel tank
6 Gravity feed from fin tank
7 APU supply line
8 Engine fuel pumps
9 Fuel control units
10 Hose-drum unit (HDU) fairing
11 Central HDU
12 Engine feed lines
13 HDU fuel supply line
14 Wingtip vent surge tank
15 Outboard No. 1A wing tank
16 Flight Refuelling Mk 32 wing pod
17 No. 1 wing tank
18 No. 2 wing tank
19 Centre tank
20 Transfer pump
21 Low pressure cocks
22 Transfer pump
23 Overwing fuel fillers
24 Pressure refuelling connection, port and starboard
25 Intermediate No. 4 wing tank
26 Transfer pump and intertank connection
27 Fuel jettison
28 Outboard No. 4A wing tank
29 Port wingtip vent surge tank
30 Starboard Mk 32 refuelling pod
31 Tank vent lines
32 Capacity reference units
33 Forward boost pump
34 Fuselage fuel cells (five)
35 Tank interconnections
36 Fuselage tank vent lines
37 Capacity reference units
38 Feed line from refuelling probe
39 Refuelling control panel at flight engineer's station
40 Fixed flight-refuelling probe



This diagram of a VC10 K.Mk 3 details the intricate fuel system of the tanker. The K.Mk 3 has the additional fin tank compared to the K.Mk 2, giving a total capacity of 104217 litres (22,925 Imp gal).

K.Mk 3s ZA147-ZA150. All were ferried to BAe Filton between March and August 1978 for rebuilding, the older machines already with the respectable total of some 45,000 flying hours apiece. Tanker conversion, to Specification K.294, was a far from new notion for the VC10, as BAC had earlier schemed a version with an additional 10,500 Imp gal (47735 litres) of capacity (as well as bomber, Douglas Skybolt cruise missile launcher and maritime patrol variants).

The current tanker has only 3,500 Imp gal (15910 litres) more than standard, contained in five equal-sized cells in the former passenger cabin. Tanks were installed via the freight doors of the 'Supers' before they were sealed, but the K.Mk 2s had to be cut in half during conversion. Six wing tanks – 1A (port outer), 1, 2, 3, 4 and 4A – in all variants of VC10 hold a total of 17,925 Imp gal (81480 litres), augmented by Cells 1-5 (numbered front to rear), the optional fin tank and some 20 Imp gal (91 litres) in each of the three refuelling units' reservoirs.

Two types of refueller are used. In the lower rear fuselage is a Flight Refuelling Ltd Mk 17B hose-drum unit (HDU) deploying up to 70 ft (21 m) of hose and capable of delivering fuel at up to 4,000 lb (500 Imp gal/2270 litres) per minute. Outboard, beneath the wings are two FRL Mk 32/2800 pods with a 48-ft (14.6-m) hose length and fuel flow of 2,800 lb (350 Imp gal/1591 litres) per minute. Normal operating speeds for tanking are between 215 and 340 kt (250-390 mph; 400-630 km/h) with either one large aircraft on the centreline or two fighters refuelling from the wing pods.

Other changes include retention of the forward passenger cabin for 17 (K.Mk 3) or 18 (K.Mk 2) ground crew and installation of an underfuselage TV camera displaying to the flight engineer's position in the four-man cockpit. For night operations, floodlights are installed to illuminate the aircraft's lower surfaces. Conversion costs, first estimated as £44 million, had grown to £79 million by the start of 1981 and further escalated to £131 million by the middle of the same year. Investigation by a Parliamentary committee revealed that initial assessment of the airframes had been hasty and underestimated the work involved.

Painted with grey and green disruptive upper surface camouflage, first K.Mk 2 conversion ZA141 flew at Filton on 22 June 1982, piloted by Roy Radford. A structural weakness in the fin resulted in it being fitted with the tail unit of an ex-civil VC10, XX914, which had recently been withdrawn from use as a testbed at Royal Aircraft Establishment, Bedford and, as such, also a delivery to Hurn, Bournemouth, where a parachute-escape door was fitted in place of the port passenger door. It was adopted on subsequent conversions and retrofitted to ZA141.

The third conversion, ZA140, was delivered to Brize Norton for training under the auspices of No. 241 OCU on 25 July 1983, but not until 1 May 1984 was a specific operating unit formed when No. 101 Squadron ZA141 was delivered to Boscombe Down on 9 June 1983 for trials by the Aeroplane & Armament Experimental Establishment. Next to be completed, ZA143, flew on 22 December 1982 wearing the definitive hemp-coloured camouflage which '141 eventually adopted. This flight was

One K.Mk 2 was initially painted in a grey/green camouflage, but otherwise the hemp scheme has been universal. VC10s served with distinction during Desert Storm, refuelling US Navy aircraft in addition to RAF machines.

Vickers VC10

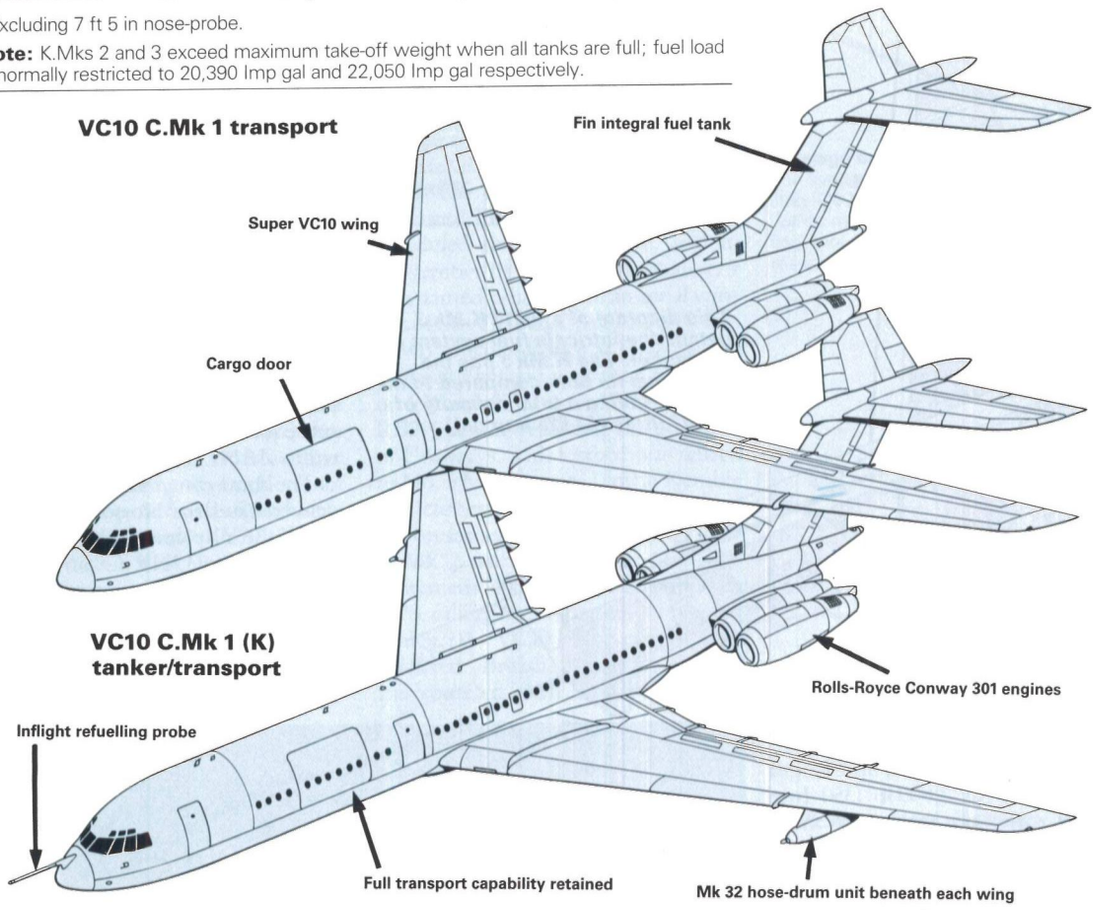
VC10 comparisons

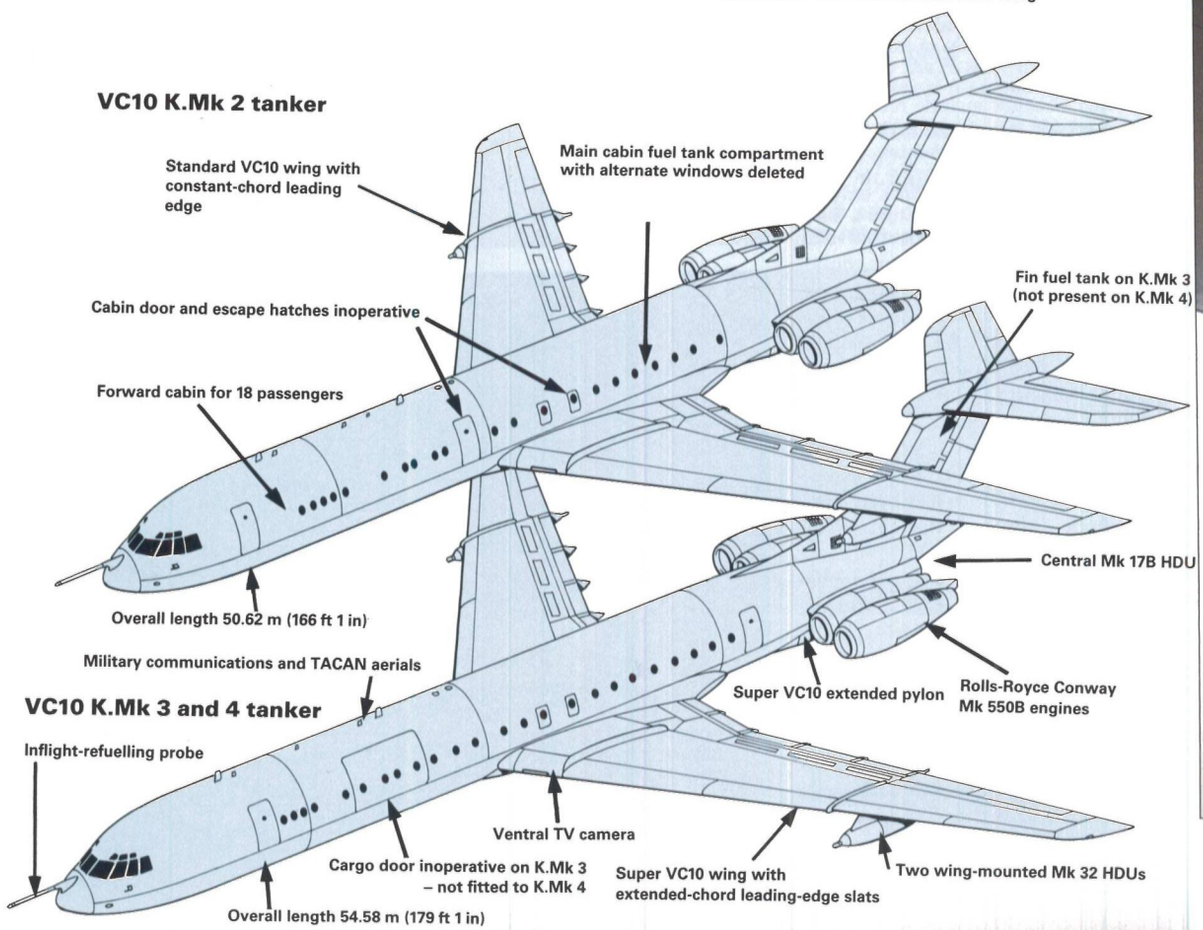
	C.Mk 1	K.Mk 2	K.Mk 3	K.Mk 4
Length*	158 ft 8 in	158 ft 8 in	171 ft 8 in	171 ft 8 in
Max weight	323,000 lb	313,000 lb	334,000 lb	
Fuel	19,365 gal	21,485 gal	22,925 gal	19,425 gal
Wings	17,925 gal	17,925 gal	17,925 gal	17,925 gal
Fin	1,440 gal	nil	1,440 gal	1,440 gal
Fuselage	nil	3,500 gal	3,500 gal	nil
Reservoirs	nil	60 gal	60 gal	60 gal

*Excluding 7 ft 5 in nose-probe.

Note: K.Mks 2 and 3 exceed maximum take-off weight when all tanks are full; fuel load is normally restricted to 20,390 Imp gal and 22,050 Imp gal respectively.

Below are the four RAF service variants of the VC10, with differences and major features detailed. The K.Mk 4 will be externally similar to the K.Mk 3.

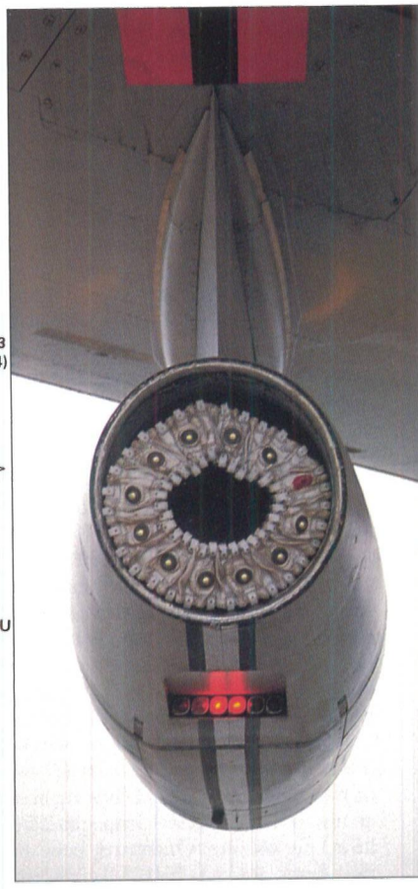

VC10 C.Mk 1 transport
Fin integral fuel tank
Super VC10 wing
Cargo door
VC10 C.Mk 1 (K) tanker/transport
Rolls-Royce Conway 301 engines
Inflight refuelling probe
Full transport capability retained
Mk 32 hose-drum unit beneath each wing


VC10 K.Mk 2 tanker
Standard VC10 wing with constant-chord leading edge
Main cabin fuel tank compartment with alternate windows deleted
Fin fuel tank on K.Mk 3 (not present on K.Mk 4)
Cabin door and escape hatches inoperative
Forward cabin for 18 passengers
Central Mk 17B HDU
Overall length 50.62 m (166 ft 1 in)
Military communications and TACAN aerials
Super VC10 extended pylon
Rolls-Royce Conway Mk 550B engines
VC10 K.Mk 3 and 4 tanker
Inflight-refuelling probe
Ventral TV camera
Cargo door inoperative on K.Mk 3 – not fitted to K.Mk 4
Super VC10 wing with extended-chord leading-edge slats
Two wing-mounted Mk 32 HDUs
Overall length 54.58 m (179 ft 1 in)

(formerly with Vulcan bombers) was established under Wing Commander David Hurrell, AFC. Despite plans for use of RAF Marham or Scampton, the new unit based its tankers alongside the VC10 transports at Brize Norton. K.Mk 3 'production' followed the five K.Mk 2s, beginning with the maiden flight of ZA148 on 4 July 1984. This machine was used by A&AEE, so No. 101's first delivery was the second conversion, ZA150, delivered to Brize on 1 February 1985 and formally accepted into service on 20 February.

Missions included support of Phantom and Lightning (later Tornado F.Mk 3) interceptions of Soviet aircraft around the UK coast and overseas flights with combat aircraft deployed for exercises and training. Refuelled by another VC10 and a Tristar, ZA147 established a non-stop flight record of 16 hours 1.5 minutes between the UK (Brize) and Perth, Australia, on 2 April 1987.

British Airways, successor to BOAC, flew its last scheduled Super VC10 service on 29 March 1981, having carried 13 million passengers in 1,137,000 hours without a single fatality. Fourteen Supers, plus 23 extra Conways, were bought by the RAF for spare parts reclamation. In April and May of 1981, 12 were ferried to RAF Abingdon for long-term storage, with engines removed and white livery daubed with dark paint as part of the airfield 'tone-down' measures.



Apart from refuelling equipment at the flight engineer's station, the cockpit of the K.Mk 3 is essentially that inherited from its airliner days. A feature is that the flight engineer has duplicate thrust levers for accurate and efficient control of the engines.

Two more went to Brize Norton. Serial numbers ZD230-ZD243 were inconsistently (and sometimes incorrectly) applied, while slow scrapping of the highest-houred airframes began in 1985. The same fate befell ZD493, a 'standard' VC10 bought from Gulf Air and flown to Brize in September 1982 for breaking down.

Various methods began to be considered of employing some of the stored Super VC10s as replacements for the RAF's last Victor tanker squadron, while during the late 1980s, there was a possibility that they would be passed over altogether in preference of a tanker conversion of the 11 Nimrod AEW.Mk 3s (which were in better condition, despite their unsatisfactory radars). In March 1989, the Ministry of Defence requested tenders to meet two needs: Air Staff Requirement 415 for conversion of five of the Abingdon Super VC10s to K.Mk 4 standard and ASR416 covering upgrading of eight No. 101 Squadron aircraft to C.Mk 1(K) standard. Submissions were received from Flight Refuelling Aviation, BAe, Marshall (Engineering) and SOGERMA of France. BAe was announced winner in January 1990, receiving a £100+ million contract, of which £40 million was offset to FR Aviation for the C.Mk 1(K) programme.

The Super VC10 K.Mk 4s will have no additional fuel beyond their normal wing and fin tankage and will therefore be comparatively short-range tankers. In terms of Mk 17 and Mk 32 pods, closed-circuit TV, air-to-air TACAN, avionics, systems and engines, they will parallel the K.Mk 3. After nine years of storage, refurbishment measures are considerable – the cost not decreased by the requirement to make the aircraft airworthy at Abingdon and then strip them down again at BAe Filton. ZD242 was flown to Filton on 27 July 1990, followed by ZD240, ZD241, ZD230 and (on 15 July 1991) ZD235. First flight was expected in the autumn of 1992, with delivery to No. 101 Squadron following in spring of 1993.

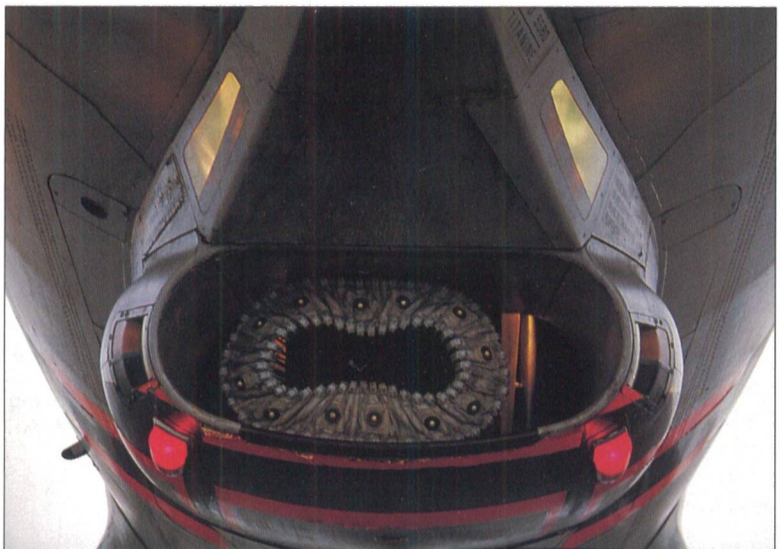
With No. 101 squadron, meanwhile, five aircraft were fitted with the optional nose refuelling probe in 1986 and more followed in the next few years. At the same time, two types of infra-red jammer were tried in mountings each side of the lower rear fuselage: Lockheed-Sanders Yukon Jack on XV107 and Loral Matador on the VVIP aircraft, XV104. The latter was subsequently fitted to other machines by 1990, at which time No. 10 Squadron began applying its winged arrow insignia to aircraft tailfins.

Utilisation of all VC10s increased as the Western coalition prepared for the Gulf War of January-February 1991, the K.Mk 2s and K.Mk 3s taking part in operational attack, combat air patrol and reconnaissance missions and using to good effect their compatibility with US Navy refuelling methods. Two tankers were fitted with Marconi Sky Guardian radar warning receivers prior to hostilities, the force flying a total of 381 sorties (1,350 hours) between 16 January and the war's end six weeks later. In March 1992, No. 101 Squadron established a detachment at Incirlik, Turkey, to support RAF Jaguars patrolling northern Iraq to protect the Kurdish population. In August of the same year, a similar element went to Dhahran, Saudi Arabia, for reconnaissance Tornados covering southern Iraq.

The FR Aviation contract was extended early in 1992 to cover all 13 remaining C.Mk 1s, of which XV101 had flown to Hurn on 28 February 1991 as the first subject for tanker conversion. Retaining full passenger and freight capability, the C.Mk 1(K) has only the two underwing pods and lacks both the centreline Mk 17 and any additional tanks. Work includes general rectification and embodiment of regular modifications as well as the tanker-related 'plumbing', and closed-circuit TV, so it was not until 11 June 1992 that XV101 returned to the air, still in its white livery. The aircraft was delivered to the retitled Aircraft & Armament Evaluation Establishment at Boscombe Down for service trials prior to the first delivery to the RAF, expected before the end of 1992. Conversion of C.Mk 1s will continue into 1995 and all VC10 tankers will receive JTIDS (Joint Tactical Information Distribution System) terminals at a later stage.

Right: Greatly increasing the flexibility of the VC10's tanker mission is the nose-mounted refuelling probe. The VC10 is generally regarded as being better than the TriStar for tactical work, but the Lockheed tanker scores on large aircraft support and deployment trails.

Both Mk 17B (fuselage, below) and Mk 32 (wings, left) hose-drum units are equipped with signal lights for receiver aircraft and aligning marks. The drogues themselves are equipped with white lights to provide visual cues for night refuelling.



In response to the increased threat from shoulder-launched SAMs, RAF VC10 C.Mk 1s began sprouting infra-red jammers in the late 1980s. Shown left is the Lockheed-Sanders Yukon Jack installation, evaluated aboard XV107, while above is the Loral Matador fitted to XV104, normally used for VVIP work. Fitment of this unit has been extended to the rest of the fleet. It transmits pulses of infra-red radiation to defeat the seeker head of missiles, and has several pre-programmed jamming codes to meet different threats, controlled from a unit in the cockpit. New codes for new missile threats can be programmed into the system.

Ilyushin Il-78 'Midas'

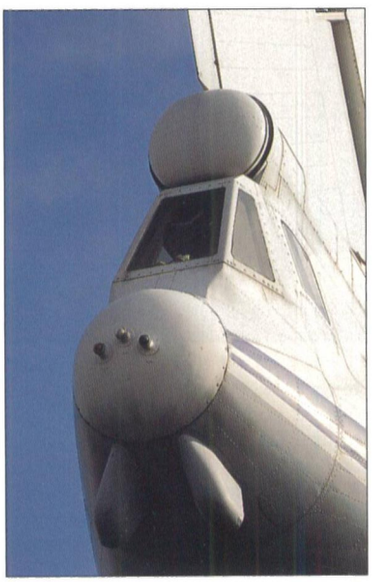
CISAF tanker

Ilyushin's Il-76 design has not only emerged as the major transport aircraft for CIS air forces, but is also increasingly the subject of modifications for a variety of special missions. Among the developments are command post versions, the AWACS platform (see *World Air Power Journal* Volume 9 for details) and, of great importance, the Il-78 'Midas' tanker.

Inflight refuelling has until recently not played the part in Soviet/CIS air force operations that it has with Western air arms. Only the Tu-16 'Badger' and Myasishchev Mya-4 'Bison' were equipped for the task. The 'Badger' had two tanker variants, one employing a wingtip-to-wingtip technique which only allowed it to refuel other Tu-16s, and one featuring a single hose-drum unit in the bomb bay. The 'Bison' also had a bomb-bay HDU. These systems offered only single-point refuelling, and were mostly used to extend the range of strategic platforms such as bombers or long range reconnaissance aircraft. Tactical aircraft were not required to have inflight refuelling capability.

Right and below: Two views of the Il-78's gun turret, which is used as a refuelling observer station. Specific equipment includes three red, green and yellow traffic lights and two forward-facing periscopes mounted underneath.

Right: A flat dielectric panel under the rear fuselage is a radar for air-to-air rendezvous.



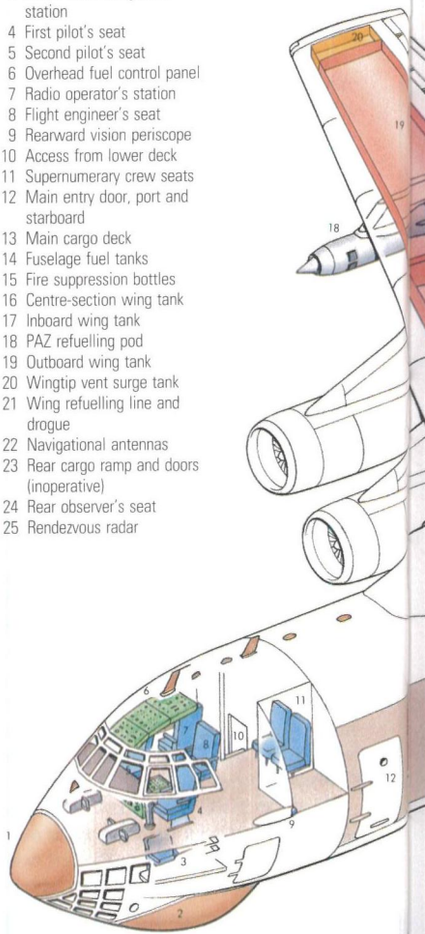
By mounting a PAZ pod on the rear fuselage, Ilyushin has negated the need to cut into the fuselage structure to provide a central refuelling point, although there are drag penalties. The pod itself is extremely neat, with traffic lights set into the rear end above the stowed drogue.

Today the accent has changed. Upheavals in the world political arena have impressed on the CIS the need for long-range tactical deployments and operations in out-of-theatre regions, and in turn this requires the inflight refuelling of tactical aircraft. Provision of this capability has progressed along two lines. Firstly, several aircraft types have been given buddy refuelling capability, notably the Sukhoi Su-24 and Su-27. Secondly, a general purpose tanker has been developed to replace the elderly bomber types for strategic support, and to provide greater flexibility for refuelling tactical receivers.

Based on the standard Il-76MD transport, the Il-78 has the same airframe but is equipped with extra fuel tankage and three hose-drum units. Indeed, judging by the registrations worn by Il-78s in Aeroflot colours, they are likely to be surplus Il-76MDs reconfigured with the tanker package. Two of the pods are on pylons under each wing, and the third is attached to the port rear fuselage. On missions with just one receiver, such as bomber support missions, the two wing pods may be removed.

Ilyushin Il-78M 'Midas'

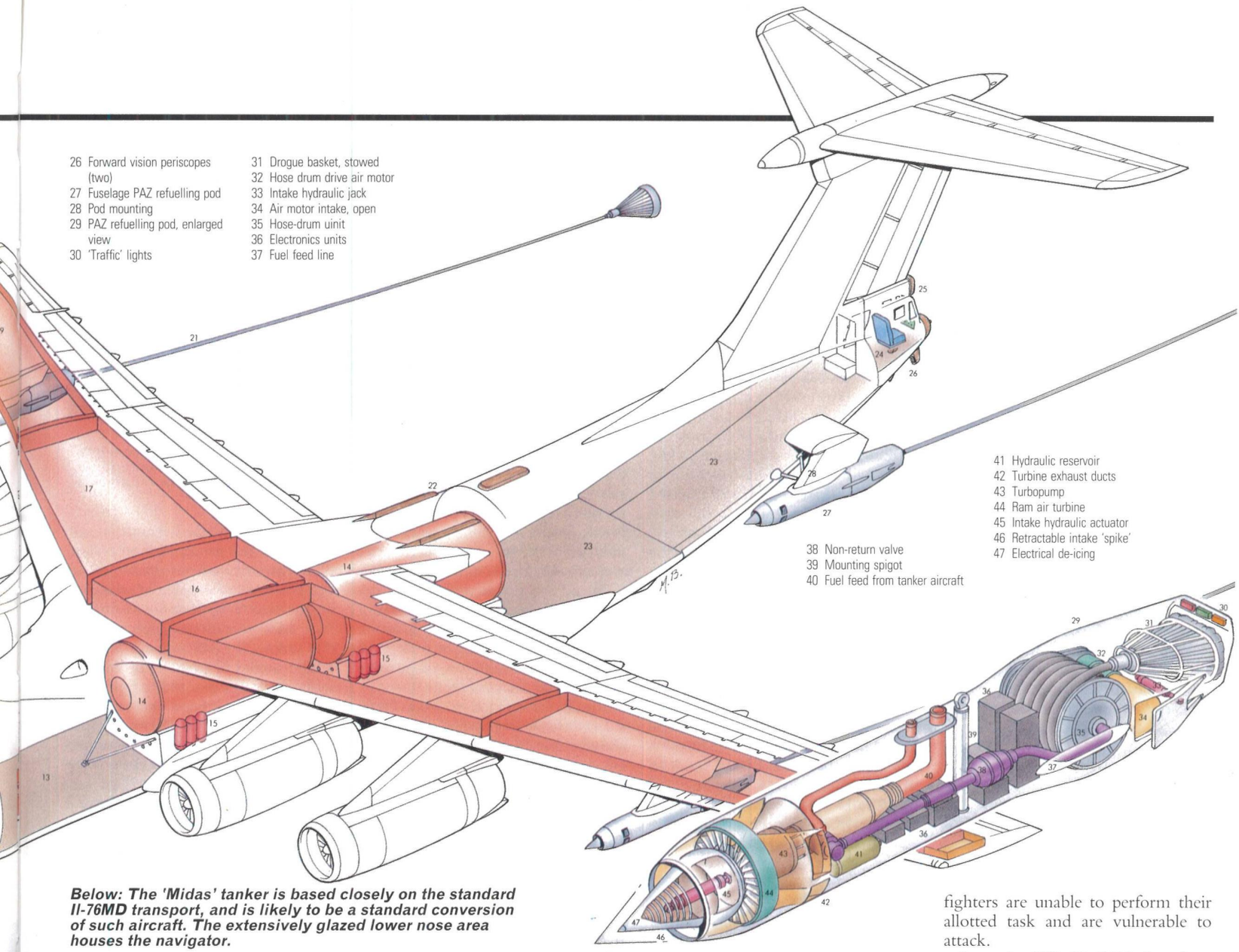
1 Weather radar
2 Navigational radar
3 Lower deck navigator's station
4 First pilot's seat
5 Second pilot's seat
6 Overhead fuel control panel
7 Radio operator's station
8 Flight engineer's seat
9 Rearward vision periscope
10 Access from lower deck
11 Supernumerary crew seats
12 Main entry door, port and starboard
13 Main cargo deck
14 Fuselage fuel tanks
15 Fire suppression bottles
16 Centre-section wing tank
17 Inboard wing tank
18 PAZ refuelling pod
19 Outboard wing tank
20 Wingtip vent surge tank
21 Wing refuelling line and drogue
22 Navigational antennas
23 Rear cargo ramp and doors (inoperative)
24 Rear observer's seat
25 Rendezvous radar



The extra tankage is housed in the main hold, comprising two cylindrical tanks mounted in tandem. Gas bottles for the tank purging system are located underneath the tank. Each tank is approximately 3.4 m (11 ft) in diameter, the dimensions of the Il-76's cargo hold. Although permanently fitted, the tanks were admitted through the rear ramp, negating the need for any structural modifications during fitment. The rear ramp remains but is inoperative.

The refuelling pods are designated PAZ, and are self-powered. In the front of each is a conical spike, which moves backwards on deployment to

Standard Aeroflot schemes grace most of the Il-78s seen by the West so far. However, the aircraft's purpose is strictly military: tanking of CIS strike aircraft and fighters.


26 Forward vision periscopes (two)
27 Fuselage PAZ refuelling pod
28 Pod mounting
29 PAZ refuelling pod, enlarged view
30 'Traffic' lights
31 Drogue basket, stowed
32 Hose drum drive air motor
33 Intake hydraulic jack
34 Air motor intake, open
35 Hose-drum uinit
36 Electronics units
37 Fuel feed line
38 Non-return valve
39 Mounting spigot
40 Fuel feed from tanker aircraft
41 Hydraulic reservoir
42 Turbine exhaust ducts
43 Turbopump
44 Ram air turbine
45 Intake hydraulic actuator
46 Retractable intake 'spike'
47 Electrical de-icing

Below: The 'Midas' tanker is based closely on the standard Il-76MD transport, and is likely to be a standard conversion of such aircraft. The extensively glazed lower nose area houses the navigator.

provide ram air through an annular intake. This provides an air stream which deploys the hose and drogue to its full length, and also drives a turbine in the forward portion of the pod which provides electric and hydraulic power. This is used to operate the fuel pump. In the rear portion of the pod is another turbine which uses air stream power to rewind the hose when refuelling is complete.

A crew of six flies the Il-78, comprising two pilots, radio operator and flight engineer on the main flight deck, radar navigator on the lower deck and refuelling observer in the tail turret. The observer has no controls, but is in radio contact with the flight engineer, who operates the fuel system, and the receiver pilot. Red/yellow/green lights are mounted within each pod, and on the tail turret, to provide radio-silent commands to receivers. The flight engineer has no TV system to monitor the refuelling from the cockpit, having to rely purely on the verbal inputs from the observer. However, a flat-faced fairing with a rear-facing dielectric panel under the rear fuselage does contain a simple homing radar to facilitate rendezvous between tanker and receiver.

The refuelling system is believed to be discrete from the aircraft's own fuel. Of about 100 tonnes carried in total, only 35 are disposable, this being the contents of the cabin tanks. Despite some features which the West would regard as archaic, the Il-78 does have some outstanding qualities as a tanker. It is easily able to refuel three receivers simultaneously, all at the maximum flow rate of 2500 litres (660 US gal) per minute. This rate is considerably greater than those achieved by Western HDUs. In tactical terms, the Il-78 is thus able to complete the refuelling of formations of tactical aircraft in a much shorter time than its Western counterparts, time in which fighters are unable to perform their allotted task and are vulnerable to attack.

In early 1991 12 'Midas' tankers were reported in Soviet service, but the figure is much greater now, perhaps having surpassed 30. Virtually all that have been seen by Western observers have worn the standard Aeroflot colour scheme with civil registrations in the Il-76MD block, but at least one in white CISAF scheme has been noted.

Wing pods are essential for missions to support tactical aircraft, but can be quickly detached for bomber or patrol aircraft refuelling sorties.

Grumman X-29/VFC

Revolutionary control system

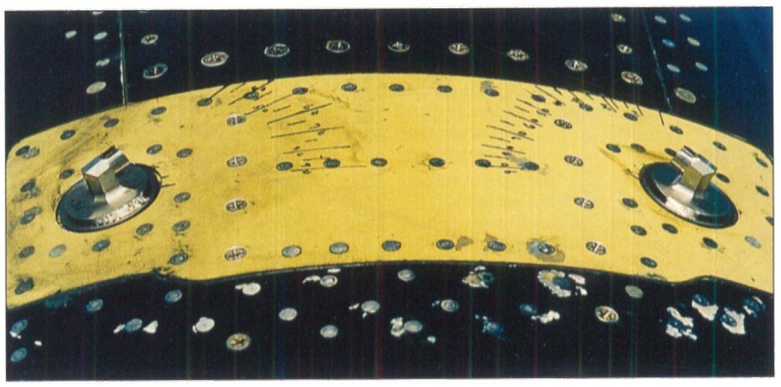
Using the second Grumman X-29 Advanced Technology Demonstrator airframe, the US Air Force has demonstrated a completely new method of controlling aircraft, one which has great potential for future fighter aircraft. VFC (vortex flow control) technology employs the use of nozzles which exhaust gas to influence the flow of vortices over the aircraft's body, so exerting control forces. This has applications at high angles of attack, the subject of much fighter testing in recent years.

The use of nozzles to effect control movements is far from new. The Lockheed NF-104 rocket-assisted Starfighter utilised reaction control jets for flight in the very thin atmosphere at high altitude in much the same way as space vehicles, while VTOL aircraft such as the Harrier use 'puffer' jets mounted at the aircraft's extremities for control in the hover or at very low speeds. However, these systems relied on direct thrust to provide control.

Based at Wright-Patterson AFB, the Aeronautical Systems Center of Air Force Materiel Command has among its assets the Wright Laboratory, Flight Dynamics Directorate. An initiative of this establishment was research into VFC using nozzles rather than mechanical vanes to influence body airflow at high angles of attack and thereby produce direct control forces. Wind-tunnel testing at Wright Laboratory produced a slotted nozzle design and showed the considerable potential of this technology, leading to it being flight-tested on the X-29.

A joint Air Force/NASA/Grumman project, the X-29 has been a major research programme into future fighter technology. The first machine (82-0003) was flown for the first time on 14 December 1984, and was primarily involved in forward-swept wing research. The aircraft was subsequently grounded on 2 December 1988 after 242 flights, and its systems raided for use in the second X-29A (82-0049), which first flew on 23 May 1989. This aircraft flew a series of high angle-of-attack trials, demonstrating controllability at 80°.

Left: This head-on view shows the location of the VFC nozzles and the instrumented air data boom. If left yaw is required, the left VFC nozzle is activated, ejecting gas inwards and thereby drawing the left-hand nose vortex closer to the aircraft's body and pushing the right vortex further out. An area of low pressure is created by coanda effect to the left side of the nose, and an area of high pressure to the right. The nose is therefore pushed to the left.



The VFC nozzles rotate through 90° deflection from the aft position. At 60° deflection a short burst gives a 20°/second yaw rate.

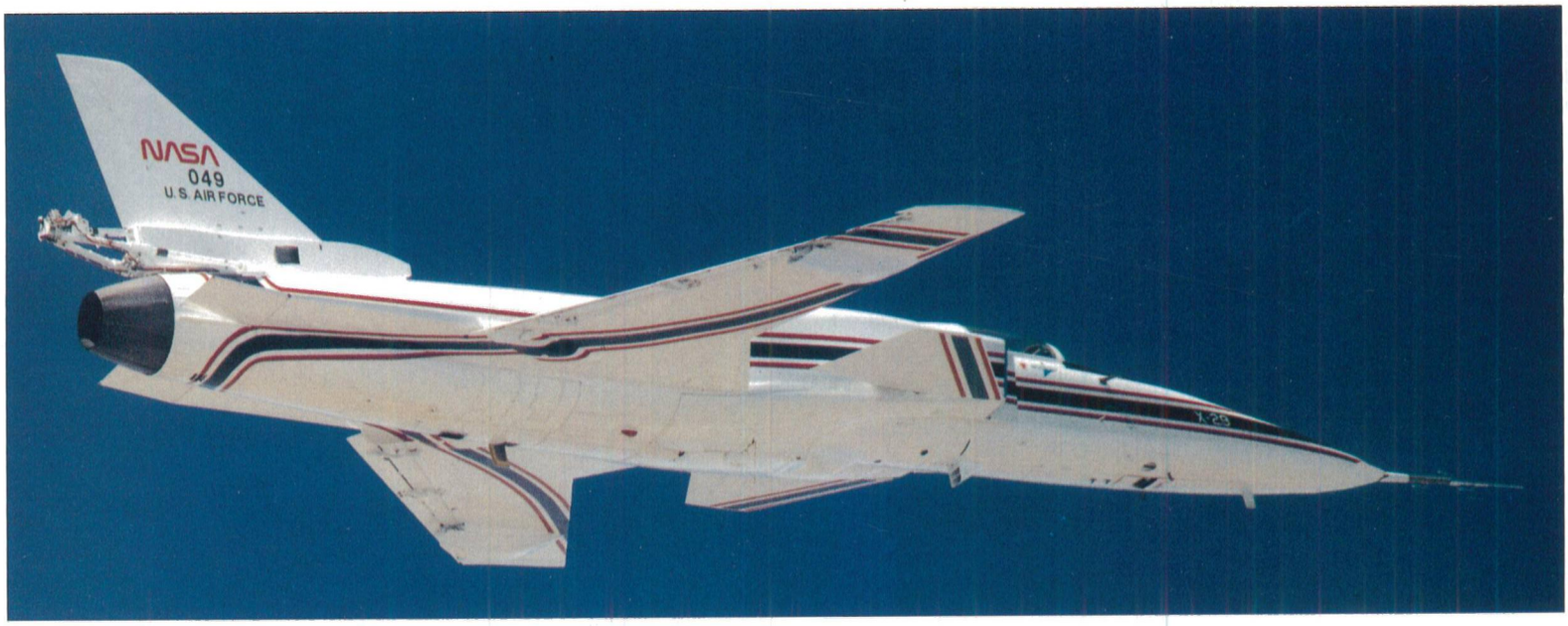
Fitment of the VFC system to the second aircraft involves locating the two swivelling nozzles on the top of the aircraft's nose, and provision of a high-pressure nitrogen system to provide gas exhaust. Two nozzle sizes were investigated at tunnel stage, with ¼-lb and 1-lb per second flow capacities. In VFC configuration the aircraft took to the air in May 1992, and took part in an extensive flight trial phase which lasted through August, involving about 40 hours of flight.

Results of early tests were better than predicted in the wind tunnel, and showed that the VFC nozzles become effective at about 15° angle of attack, become more powerful than the conventional rudder at 30°, and demonstrate complete effectiveness at 50°. Control at angles of attack greater than 50° were anticipated in the later part of the flight tests, which were being undertaken by Air Force pilot Major Regis Hancock, and NASA pilots Steve Ishmael and Gordon Fullerton.

Wright Laboratory's VFC Chief Engineer, Larry Walchli, described the impact of VFC technology as representing "a breakthrough in directional control at high angles of attack as significant as the Wright brothers' rudder was to conventional flight." Certainly the implications are enormous for future fighter design. Conventional control surfaces run out of influence as the angle of attack increases, but VFC continues to work. Not only would the application of VFC technology allow controllability at high angles of attack to be dramatically increased, permitting fighters to be quickly positioned and stabilised for missile firing in the high-alpha regime, it may also allow the reduction in fin size in future designs, or even the elimination of vertical surfaces altogether. This would have a double-edged advantage of cutting both drag and radar reflectivity.

Lieutenant Colonel William Gotcher, X-29 programme manager, suggests that an operational fighter could be fitted with a VFC system for future trials. In any operational design, the VFC system would almost certainly use engine bleed air rather than the pressurised nitrogen system currently carried by the X-29A.

The second X-29 has been the main high angle-of-attack test-ship. Here it is seen fitted with a spin recovery parachute.



Procured specifically for Southern Command, the C-27s provide STOL airlift capability for a variety of duties. These include the support of Special Forces and drug-busting operations.

Chrysler C-27A Spartan

Cargo carrier

Chrysler C-27A Spartan: hardly a name constantly on the lips of the aviation enthusiast and professional, but an aircraft perhaps better known by its alternative name(s) of Alenia (née Aeritalia, née Fiat) G222. Until recently appearing to be approaching the end of its production history – with orders near satisfaction for just under 100 machines – this medium-sized STOL transport gained second wind when it secured a USAF commitment to 18. Now in service, the C-27A has demonstrated that it has the versatility to operate where even the trusty Lockheed C-130 Hercules would find the going too tough.

The need for such an aircraft to augment the USAF in Central and South America had long been known and resulted in the promulgation of a requirement in 1986 for what was termed a Rapid Response Intra-Theater Airlifter. Basic parameters included an ability to fly from fields under 3,500 ft (1065 m) in length; pressurisation for crossing mountainous areas; and a ferry range exceeding 1,500 nm (1,725 miles; 2780 km). Department of Defense type designation C-27 was assigned long before a specific aircraft was chosen from those competing for the contract, and procurement was planned of 10, including the first five to be funded in FY 1988. The sum of $126 million was set aside for the 10, but financial constraints twice intervened. When the C-27 was deleted from the FY 1989 budget in March 1988, the sole US competitor, Bromon's BR-2000, was stifled before birth.

C-27 returned to the fore in August 1990 when the G222 was chosen in preference to the rival Airtech (CASA-IPTN) CN.235. An initial order worth £80 million was placed on 20 August for five aircraft, with Chrysler Technologies Airborne Systems Inc. of Waco, Texas, responsible for outfitting and delivery. The C-27A – named Spartan early in 1992 – differs in detail from the G222, its published performance data also diverging in some areas from that hitherto emanating from Turin.

In Italy, the C-27 is modified from G222-710 to -710A standard with the addition of an anti-skid braking system, a modified cargo compartment and provision for crew oxygen. Delivery then takes place to Chrysler in overall European One camouflage, using an Italian civil registration. At Waco, the G222 becomes a C-27A with extensive modification by Chrysler, including a revised cockpit, aeromedical evacuation equipment and a loadmaster's position. Avionics changes include a Litton LTN-92 inertial navigation platform, AN/ARN-154 TACAN, AN/ARC-201 SINCGARS secure VHF-FM radio, AN/ARC-186/187/190 VHF/UHF/HF, DME, cockpit voice recorder, flight emergency beacon locator, data recorder, IFF and ground proximity warning system. There is also a frequency converter to adapt aircraft electrical power for use by life support systems when the C-27 is being used for medical evacuation.

Boosting US Southern Command's transport capability, the Spartan is tasked with general transport and a number of non-standard missions, including delivery of Special Forces and anti-drug operations. The aircraft is supplementing USAF Hercules in countries including Panama, Brazil, Peru, Honduras and Colombia. It can operate from 90 per cent of Latin America's 10,000 airfields, whereas the Hercules can use only 10 per cent of them. Maximum loads may include 34 combat-equipped troops, 24 paratroops, 24 stretchers and four attendants or 14,859 lb (6740 kg) of palletised cargo – such as an HMMWV general-purpose vehicle or M119 howitzer and crew. A typical mission profile specified by the USAF is take-off with a 10,200-lb (4630-kg) payload from a 3,500-ft (1070-m) unpaved runway at ISA+15°C; fly 200 nm (230 miles; 370 km), half at 10,000 ft (3050 m), the remainder at 300 ft (90 m) AGL; land on a 1,800-ft (550-m) unpaved runway; and return to base without refuelling, employing the same altitudes.

Conversion of G222s to C-27As began on 15 April 1991 when I-RAIS (neither the first, nor last use of this Italian test registration) was accepted at Turin. Delivery via the Azores began two days later and after modification at Waco the aircraft flew again on 30 July 1991, now serialled 90-0170. Following acceptance by the USAF on 16 August, 90170 was delivered to Pope AFB, North Carolina, for 45 days of Qualification Operations Test & Evaluation. Allocations to the Spartan's first operational unit, at that time designated MAC's 310th MAS of the 61st MAG at Howard AFB, Panama, began with 90171 on 26 September 1991, the aircraft joining the squadron's two C-130Hs, single C-21A LearJet and Boeing T-43A and replacing its loaned CASA C.212s.

Meanwhile, a further five C-27As had been ordered on 4 February 1991 for $72.6 million and plans made for eight more to be obtained: five in FY 1993 and three in FY 1994. Chrysler is also under contract to train two crews per aircraft. Pilots and loadmasters have come mainly from the C-130 and C-141 worlds, but co-pilots are often on their first operational tour after flying school. Since June 1992, the Spartan has belonged to the newly-formed Air Mobility Command, its operator designated the 310th Airlift Squadron, 61st Airlift Group.

Specification
C-27A Spartan

Empty weight: 35,500 lb (16103 kg)
Maximum payload: 14,859 lb (6740 kg)
Useful load*: 18,678 lb (8472 kg)
Maximum take-off weight:** 56,878 lb (25800 kg)
Maximum cruising speed: 250 kt (207 mph; 463 km/h)
Service ceiling: 22,000 ft (6706 m)
Take-off run with 4,000 lb cargo: 1,500 ft (457 m)
Operating range: 300 nm (344 miles; 555 km)
Ferry range: 1,500 nm (1,726 miles; 2779 km)

*Can be all fuel
**From unpaved surface

In 1992 C-27s of the 24th Wing were heavily involved in evacuating personnel from Homestead AFB to Patrick as the storm clouds of Hurricane Andrew approached the Florida base.

Russia's 'Manned Patriot'

Often dismissed in the West as a crude, brutish adaptation of the near-obsolete MiG-25, the MiG-31 is in fact one of the world's most sophisticated long-range interceptors, tailored to meet the very specific air defence needs of the former USSR. So effective is the MiG-31 that its creators describe it as a re-useable manned alternative to the Patriot missile.

Below: The first MiG-31s seen by the West were encountered by Norwegian fighters during 1985, and included this aircraft. This appeared to have one 'segmented' afterburner nozzle and one plain, and led to much head-scratching among Western analysts. Operating from bases on the Kola Peninsula, these aircraft soon became regular 'trade' for Norwegian F-16s.

By the 1970s, Soviet air defences were in a pitiful state. Russia's Tu-114 'Moss' was available only in very small numbers, and was of limited capability, while the vast network of SAMs had progressed little since the U-2 of Francis Gary Powers had been blasted from the sky over Sverdlovsk on 1 May 1960. The huge IA-PVO interceptor force was equipped with a variety of aircraft, from ageing Sukhoi Su-11 'Fishpots' and MiG-21 'Fishbeds' to newer MiG-25 'Foxbats'. None of the types in service were capable of meeting the threat posed by low-level NATO strike aircraft, by new long-range stand-off missiles or by the new generation of Western agile fighters. Many of the types in use, particularly the lumbering Tupolev Tu-28 'Fiddlers' and Yak-28 'Firebars', were beginning to show their age.

Work on overhauling Soviet air defences was accorded a high priority, and development began on two new AWACS platforms (the A-50 'Mainstay' and An-74 'Madcap'), an array of new SAMs, and various new fighters. The most ambitious of these were the MiG-29 'Fulcrum' (intended as a tactical fighter for Frontal Aviation) and the Sukhoi Su-27 'Flanker' (a long-range agile interceptor and escort fighter for the IA-PVO and Frontal Aviation). Both of these aircraft were single-seaters, and neither promised to be in service before 1985, so a number of interim fighter projects were instituted. New lookdown/shootdown radar was fitted to the existing Su-15 to produce the Su-15 'Flagon-F', while a similar process produced the MiG-25 'Foxbat-E'. The IA-PVO also took delivery of large numbers of MiG-23 'Floggers', which had a limited lookdown/shootdown capability.

Although often assumed to have originated as an interim aircraft, or at best as an insurance policy in case of the failure of the Su-27, the MiG-31 actually represented an attempt to produce a long-range interceptor which would be capable of operating independent of ground con-

Left: The 'Foxhound' is a massive fighter, and dwarfs its crew, who are accommodated in tandem in separate cockpits.

Right: Mikoyan's MiG-31 demonstrator has become a common sight in the West, having visited Farnborough, Paris, Berlin, Singapore, Dubai and even some air shows in the USA. Chief test pilot Valery Menitsky is happy to admit his preference for the MiG-29, but displays the bigger interceptor with great verve. Inset right: An early development aircraft carries an unusual three-digit nosecode.

'592', a development aircraft retained by the OKB, carries a load of R-33 (AA-9 'Amos') and R-40 (AA-6 'Acrid') missiles. The older AA-6 is used as a medium-range complement to the AA-9. The underside of the nose has been painted black ahead of the IRST sensor.

trol, and whose two crew members would also enhance mission performance in a hostile electronic warfare environment, and not just a low-risk, quick-to-develop Su-27 alternative.

In order to minimise the gestation period of the new fighter, Mikoyan did, however, use the basic configuration of their MiG-25, albeit with strengthened structure and new materials for high-speed flight at low altitudes. The airframe of the new aircraft is thus 50 per cent steel, 16 per cent titanium, and 33 per cent duralumin, with only very small amounts of composites. The comparable proportions for the MiG-25 were 80 per cent steel, 8 per cent titanium and 11 per cent aluminium alloys.

The MiG-31 airframe seems to have originated from that of the Ye-155M, a research derivative of the MiG-25 intended to explore ways of increasing the speed and range of the MiG-25 family. It had been intended to undertake a two-stage programme, first fitting new 132-kN (29,761-lb) R-15BF-2-300 engines (32 kN/7,253 lb more powerful than the R-15B-300 of the standard MiG-25) and then revising the aircraft structure to raise the limiting Mach number (which was then thermally limited to Mach 2.83). With the new engines, service ceiling was raised to 24200 m (79,396 ft), and range increased to 1920 km (1,193 miles) or 2510 km (1,559 miles) with a 5300-litre (1,166-Imp gal) external tank.

Unfortunately, engine development took longer than anticipated, and the second stage of the programme, covering structural and material changes, was shelved. The two Ye-155M prototypes, however, still had a role to play, and were converted to serve as engine testbeds for the new 152-kN (34,170-lb) Soloviev D-30F6 dual rotor turbojets being developed for the MiG-31, after a fierce competition between Soloviev and Tumanskii.

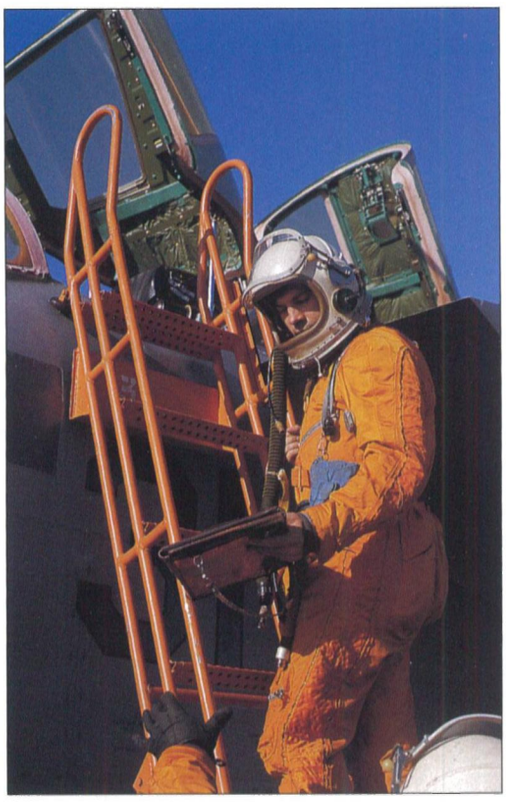
Powerplant from Perm

The Soloviev D-30F6 was designed at Perm by a team led by Soloviev himself (and since 1989 by Yuri Reshetnikov) with development beginning in 1972. The team was formed by two companies, Aviadvigatel and Motorostroitel. Development was finally completed in 1980. The

Crewing up a PVO MiG-31 at an unidentified airbase, although the snow-covered mountain in the background must offer some kind of clue. Integral steps are not provided, and the crew rely on huge ladders to reach their lofty perch.

engine is manufactured at Perm's Motorstroitel works, and is claimed to be a derivative of the same D-30 engine that is used to power the Ilyushin Il-62M and Tupolev Tu-154M. The bypass turbofan gives an excellent specific fuel consumption in the cruise, while the bypass flow around the engine's inner core reduces thermal stresses on the engine. In this context, the 5 kg (11 lb) of silver used to give a reflective coating to MiG-25 engine bay heat shields has been dispensed with on the MiG-31. One unique feature of the D-30F6 is the use of small suction relief doors on the moving parts of the engine nozzles to eliminate pulsing in the exhaust gases.

The engine consists of seven modules, six of them replaceable. The first is an inlet guide vane module, with the others being the five-stage low pressure compressor, the mixer case, the afterburner, the exhaust nozzle, front and rear gearboxes, and a base module with the 10-stage high pressure compressor and combustion chamber, first stage nozzle vanes, high and low pressure turbines (both two stage) and rear bearing. The engine has a mass flow of 150 kg (330 lb) per second and an inlet diameter of 102 cm (40 in). The D-30F6 features an integral heat exchanger using fan bypass air to cool air drawn from the compressor which in turn cools the high- and low-pressure turbines. A turbine overspeed protection system is fitted, along with an exhaust temperature limiter. Full authority digital engine controls are fitted, with a data recording system.



MiG-31 aircrew routinely operate at very high altitudes, and these distinctive orange pressure suits and full-face sealed pressure helmets are almost* de rigueur. *The prototypes which preceded the MiG-31 shattered many records, including that for sustained altitude.

The new engine was specified for the MiG-31 in order to improve range, since this was the key performance parameter for which an improvement over the MiG-25 was demanded. The new powerplant necessitated some structural modifications, and the opportunity was taken to increase internal fuel capacity to 19700 litres (4,333 Imp gal) (some estimates suggest 20380 litres/4,483 Imp gal). This, together with the lower specific fuel consumption of the D-30F, raised supersonic range to 2135 km (1,327 miles) on internal fuel, or to 3310 km (2,057 miles) at subsonic speeds. Increased weight reduced operational ceiling to 21900 m (71,850 ft).

Record breaker

Under the 'cover' designation Ye-266M the re-engined Ye-155M shattered a number of world records. On 17 May 1975 OKB Chief Test Pilot Alexander Fedotov set time-to-height records of 2 minutes 34.28 seconds to 2500 m (8,202 ft), and 4 minutes 11.78 seconds to 4000 m (13,123 ft). His deputy, Ostapenko, took the 3000-m (9,843-ft) record with a time of 3 minutes 9.8 seconds. On 22 July 1977, Fedotov took two more records, those for altitude (achieving 37080 m/121,653 ft) with 1000- and 2000-kg/2,204- and 4,409-lb payloads. The Ye-266M's final record, set by Fedotov on 31 August 1977, was an absolute altitude of 37650 m (123,524 ft).

The MiG-31 (which bore the internal designation Project 83) was so closely based on the experimental Ye-155M that it was originally designated Ye-155MP, and was expected to gain the service designation MiG-25MP. The first prototype, bearing the code 831 (indicating the first example of project 83), first flew on 16 September 1975, in the hands of Fedotov.

The Ye-155MP (as it then was) was a very different aircraft even to the Ye-155Ms which preceded it. Most obviously, the new aircraft was a two-seater, with a weapons system operator in the rear cockpit. A retractable periscope is fitted above the rear cockpit, this giving the backseater his only view directly forward. Another brand new feature was the undercarriage, which featured side-by-side nosewheels and offset tandem mainwheels. The rear wheel on each main undercarriage unit was located outboard of the oleo, leaving a large fore-and-aft gap between the wheels. This meant that on fresh snow the rear wheel bit into new snow, rather than following in the furrow of compacted snow left by the front wheel. During rough field operations the wheels spread the wear and tear more evenly on any unhardened runway. Mikoyan's Designer General, Rostislav Belyakov, has stated that the use of tandem mainwheels, like the Saab Viggen, would render a temporary airstrip unuseable within 24 hours. The aircraft touches down on the rear (outboard) wheels first on landing, then rotates on to the forward pair. Another feature intended to permit a degree of rough field operation is the heavy-duty mudguard on the nosewheel, common to most Soviet tactical aircraft.

The new aircraft also featured new airbrakes, having twin doors which opened diagonally outwards from the bottom 'corners' of the fuselage, just ahead of the undercarriage. The wing planform was also subtly changed, with the deletion of the MiG-25's distinctive anti-flutter wingtip pods and the addition of small leading-edge extensions at the wingroots. The trailing edge is now almost fully occupied by flaps and ailerons.

In the West, the first indication that a 'Super MiG-25' was under development came in September 1976, when Lieutenant Victor Belenko defected to Japan in an early-model MiG-25. He described a MiG-25 with a stronger airframe for supersonic flight at low altitude (the MiG-25 was limited to 575 mph/925 km/h at sea level), with uprated engines, new avionics and new fuselage pylons for six examples of a new long-range missile. He also revealed that the new aircraft would have an internal gun, advanced lookdown/shootdown radar and a genuine anti-cruise missile capability. His description provided the inspiration for Craig Thomas' novel *Firefox*, but was taken with a pinch of salt by many experts and, apparently, intelligence agencies.

The West began to refer to the new aircraft as the MiG-31 in 1977, and began to sit up and take notice when a MiG-31 prototype was observed by a satellite destroying a target at below 200 ft (61 m), at some 20 km (12 miles) range, while itself at 20,000 ft (6096 m). In a later test a MiG-31 at 55,000 ft (16765 m) destroyed a UR-1 RPV flying at 70,000 ft (21336 m). The reporting name 'Fox-hound' was announced in mid-1982, and

examples of the new type started to be intercepted by Norwegian air force fighters from 1985. At one stage, Western experts were happily stating that a single-seat version had been flown, and that 24 examples of a strategic reconnaissance version were in service. Both reports seem to have been mistaken. The West was, however, taking the MiG-31 seriously, and some began to overestimate the new interceptor. US Assistant Secretary of State for Defense Donald Latham went as far as to describe the MiG-31 as being superior to any existing US fighter, including the F-15. He claimed it had "better avionics, a better C^3 system to work into, a better air-to-air missile, it is faster, has greater combat range, and the Soviets are producing it like Gangbusters."

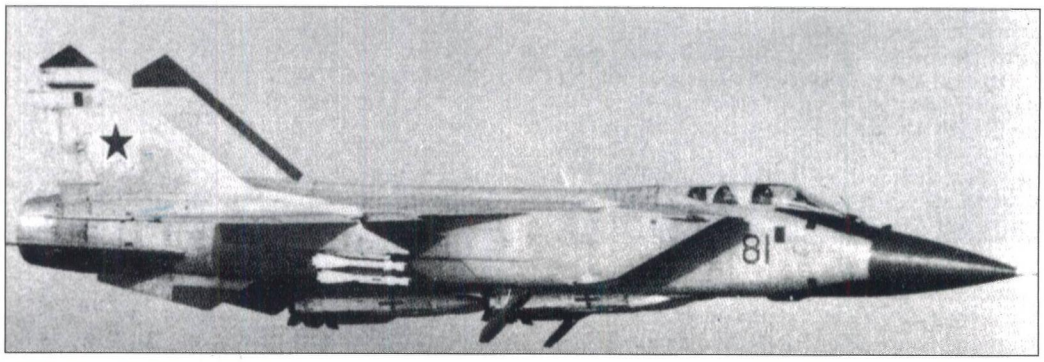
Series production

Meanwhile, series production of the MiG-31 had commenced at Gorky (now Nizhny Novograd) in 1979, after intensive trials. These were not without incident, and showed the need for a variety of modifications. The leading-edge slats were divided into four sections and fixed leading-edge root extensions were added inboard. The slats deploy to a maximum of 10° for lift enhancement at low speeds, but also function automatically as manoeuvre flaps. The wing trailing edge comprises outboard ailerons (with 40° of travel) and inboard flaps which have a maximum setting of 30°. A final aerodynamic improvement was to reposition the airbrakes underneath the intake duct, rather than on the intake duct 'shoulders'. These are hinged at the forward edge and also act as the forward doors covering the main undercarriage wells. They have no limiting speed, merely retracting (or refusing to extend) when aerodynamic pressure overpowers their hydraulic actuators. The aircraft structure was also beefed up to withstand the stresses of supersonic low-level flight. This had been proved to be necessary when airframe cracks appeared while Alexander Krutov was pulling 5 *g* at Mach 2.6 at 15000 m (49,213 ft). The main structural change was the addition of a third longeron.

By comparison with the MiG-25, the MiG-31 has larger and more complex engine intakes, and these have been tailored to eliminate airflow problems like those which ruined the fuel consumption figures of the 'Foxbat'. The MiG-31's intakes have hinged lower lips and sophisticated moveable ramps in their 'roofs'. Two-in (5-cm)

Above: Despite many early Western reports to the contrary, there has never been a single-seat version of the MiG-31, nor has the type served in the strategic reconnaissance role. This aircraft is actually a standard two-seater.

Below: This MiG-31 carries a pair of R-60 (AA-8 'Aphid') IR-homing short-range AAMs under the starboard wing. Another pair could be carried to port, or could be augmented by a single R-40. The short-range missile armament is augmented by a built-in 23-mm cannon scabbed on to the starboard side of the rear fuselage.



Below: A visiting PVO MiG-31 cruises through the murk somewhere in the Moscow Air Defence District, the order of battle of which does not include a MiG-31 regiment. Slower than the older MiG-25, the 'Foxhound's' Mach 2.83 top speed nevertheless makes it one of the fastest fighters in service.

Above: MiG-31s wait outside their hardened aircraft shelters. MiG-31s often operate in fours, with the formation leader acting as a mini AWACS, receiving radar inputs by datalink from his wingmen, allowing them to cover huge 'wedges' of airspace.

Left: A PVO navigator straps into the back seat of his MiG-31. The growing complexity of onboard systems has made a second crew member vital on modern interceptors, and for practical reasons the backseater is often the tactical commander of the aircraft, with the pilot acting as the 'driver, airframe'.

diameter blow-in auxiliary ports are located midway back along the intake ducts, cooling the engine compartments, and air in the intakes that has been heated by surface friction at high supersonic speeds.

The initial trials also showed up the need for inflight refuelling, and a crude semi-retractable probe was added to the port forward fuselage. This was not fitted to early production aircraft, but is now virtually standard equipment. At that time inflight refuelling was fairly unknown in the Soviet Union outside the long-range bomber force, and the Mikoyan test pilots had to master and then develop the techniques of fighter inflight refuelling. This, combined with the aircraft's low fuel consumption in the supersonic cruise, allowed some very long duration and long distance flights by the first MiG-31s, demonstrating impressive refuelled intercept ranges and refuelled CAP endurance. The flights involved several test pilots, including Anatoly Kvotchur, who demonstrated a gruelling five hours at maximum altitude (wearing full pres-

Right: The MiG-31's systems allow it to operate with a measure of independence from the traditionally tight Soviet GCI network. The aircraft's long range allows it to plug the most remote gaps in ground radar coverage.

Above: The cannon pack of the MiG-31 is clearly visible below the wingroot, just behind the main undercarriage well. The scabbed-on cannon pod contains a GSh-23-6 23-mm six-barrelled cannon, useful for firing a 'warning shot across the bows', for destroying low-value targets, in a turning fight (though the wise MiG-31 pilot will avoid allowing his unwieldy mount to become embroiled in such an engagement) or for administering the coup de grâce to a damaged victim.

Left: Like many two-seat Soviet fast jets, the MiG-31 has a periscope to give its backseater a better view forward on the ground or on approach. This is normally extended when the undercarriage is down, but can be disabled. This taxiing MiG-31 carries a pair of R-60 missiles underwing, sharing the same pylon.

sure suit), and Takhtar Aubakirov, who undertook a number of flights at extreme northerly latitudes to test the aircraft's navigation system. Roman Taskaev 'topped' this by overflying the North Pole, flying on to Chukotka. The nine hour return journey along the northern coastline to Moscow was an impressive feat. The accuracy of the navigation system and low fuel consumption encourage great crew confidence during long over-water missions, although a single engine failure drastically reduces range or endurance.

Without inflight refuelling the MiG-31 has demonstrated a combat radius of 720 km (447 miles) at Mach 2.35 (carrying four AA-9 'Amos' and no underwing stores), or 1200 km (745 miles) at Mach 0.85 in the same configuration. The addition of two underwing 2500-litre (550-Imp gal) fuel tanks adds 200 km (124 miles) to the radius.

The team which designed the MiG-31 was led by three successive chief designers, the first of whom was Gleb Lozino-Lozinsky (who went on to design the Buran shuttle orbiter). He was followed by Konstantin Vasilchenko (now director of the Flight Testing Institute) and finally by Anatoly Belosvet, who remains in harness at Mikoyan today.

Deliveries to the PVO began in 1983, while testing continued at a furious pace. Fedotov and his backseater, Valery Zaisev, were actually killed in the crash of a MiG-31 on 4 April 1984. Today there are more than 200 MiG-31s in service with five or six regiments of the PVO, most of them at bases covering the northern and Pacific coasts of the former USSR. One is believed to be the 180th Fighter Interceptor Regiment, based at Gromova, while another is based on the Kola Peninsula, a regiment near Arkhangelsk, a regiment near Murmansk, and at least one regiment at Dolinsk on Sakhalin Island, scene of one of the PVO's most ignominious recent debacles when short-ranged MiG-23 and Su-15 interceptors were rushed by the ground control on which they depended into downing an off-course Korean Boeing 747. The MiG-31's capacity for autonomous action and long range should make such mistakes virtually impossible.

'Flash Dance'

The key to the MiG-31's effectiveness lies in its weapons system, which is probably the most effective ever fitted to a Soviet fighter aircraft. The heart of the system is the SBI-16 Zaslon radar, codenamed 'Flash Dance' by NATO. This is said to be the world's most powerful fighter radar, with a higher output in kilowatts than any other radar. When a MiG-31 visitied the 1991 Paris air salon, the radome was removed in the static aircraft park (much to everybody's surprise), revealing the radar's fixed, phased array antenna, believed to have been the first such antenna in a fighter. The radar's designers (the Research Institute of Equipment Design) describe such small phase array radars as 'Arrowhead' radars, this being a partial acronym (ARRays Of High Efficiency And Directivity) and claim a number of advantages. Since the antenna cannot move, the radar beam is 'pointed' electronically. The fixed antenna allows the full fuselage diameter to be used for the antenna, with no space for movement. This is significant since antenna diameter and effective operating range are directly related. The fixed antenna allows the radar beam to be steered faster and more accurately than with a conventional moving antenna, and allows 'controlled beamshaping'. The radar designers also claim that fewer sidelobes are generated (and that such sidelobes as are generated can be better controlled). They also claim that reliability and radar gain can be maximised while minimising weight and complexity.

Mikoyan claims that the antenna also allows rear hemisphere coverage, through 120° on each side of the centreline. This is remarkable, since even with no rearward facing capability, the proximity of the radar emitters to the pilot would

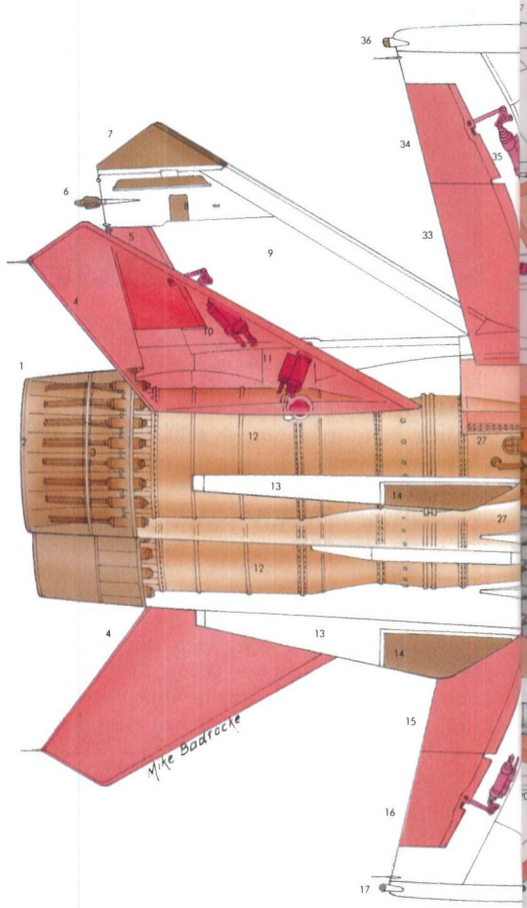
Fully laden, the MiG-31 weighs as much as three AV-8Bs or a pair of Canberras. To bring such a heavy aircraft to a halt the MiG-31 has powerful brakes and a pair of large braking parachutes. These give a large area without scraping along the runway as a single larger chute might.

seem potentially hazardous. The only other operational phased array electronically steered antenna is that of the APQ-164 radar of the B-1B. Tired of accusations of copying Western technology, Soviet designers are eager to point out that their radar was in service two years before that of the B-1B.

The radome of the MiG-31 at Paris was covered by thin muslin, which obscured some details. Waveguides were not visible, but there did appear to be 24 horizontal rows of metallic emitters. Small dipoles spread across the face of the radome are probably for IFF or constant wave illumination for a semi-active radar-homing missile. It is uncertain as to what waveband is used, although Yuri Guskov, chief designer at Phazatron, has stated that the radar operates at "slightly lower than S-band" which corresponds to NATO's D-band. This raises more questions than it answers, since some Western analysts suggest that such a waveband would give a wide beam and inadequate resolution at long range. I- or G-bands are felt by some to be more likely, and *Aviation Week* stated that the radar operated in the mid I-band (9-9.5 GHz). All signal processing is digital.

The radar allows the simultaneous tracking of 10 targets, and the simultaneous engagement of four targets. The aircraft's BTsVM(S) mission computer automatically selects the four most threatening targets for engagement. Radar performance is impressive, with a detection range (for a target with 16 m^2 (172 sq ft) cross-section) of 200 km (124 miles) and a tracking range of 120 km (74 miles). The phased array antenna

The main undercarriage doors of the MiG-31 swing down to act as airbrakes on approach, as seen here. No other airbrakes are fitted. This arrangement has been retained on the new MiG-31M. The brake chutes are housed in the long fairing between the engine nozzles.



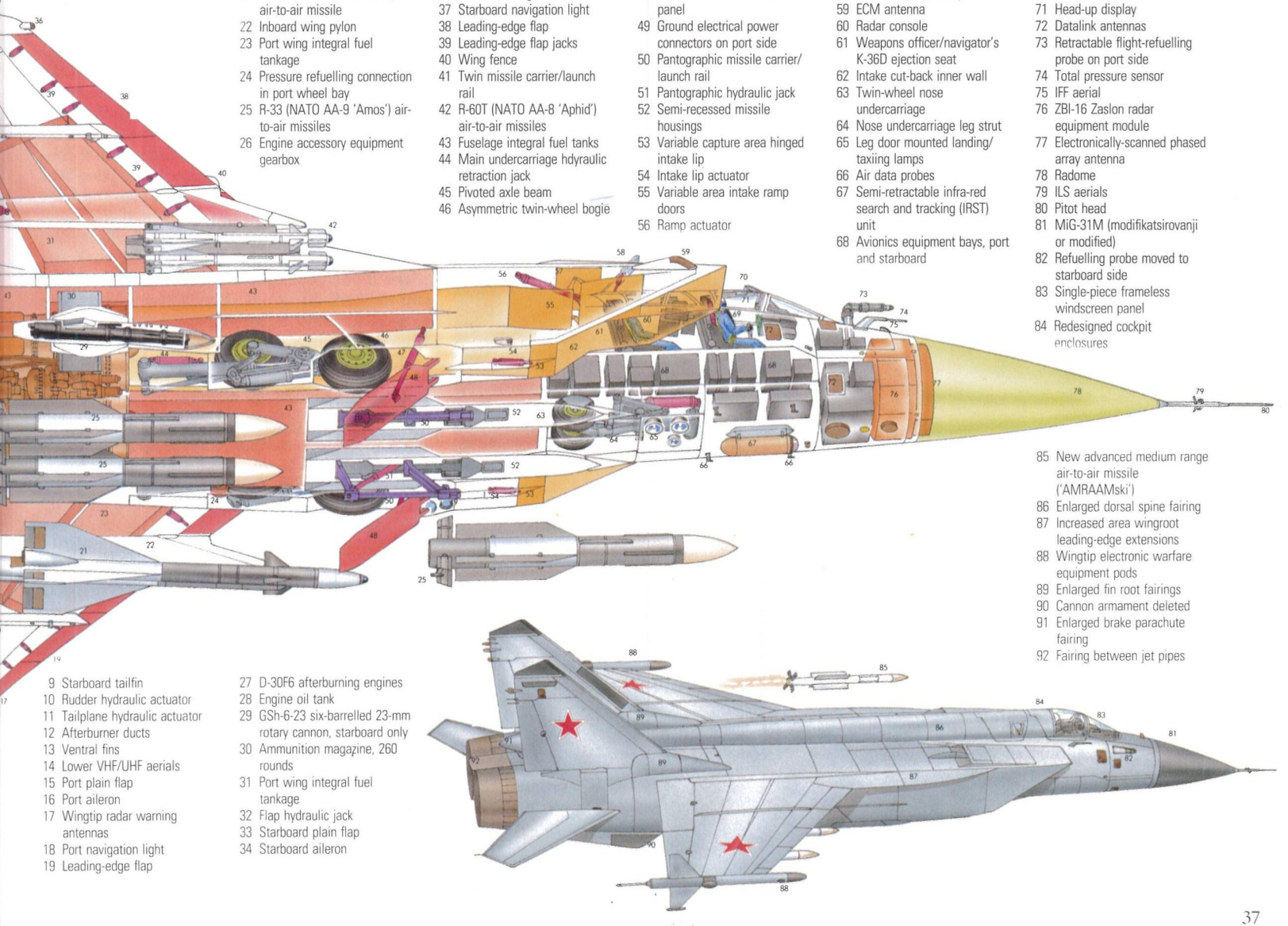
Mikoyan MiG-31 'Foxhound'

1 Afterburner nozzle shrouds
2 Variable area convergent/ divergent afterburner nozzle
3 Fueldraulic nozzle jacks
4 All-moving tailplanes
5 Rudder
6 Navigational antennas
7 Fin-tip VHF/UHF antenna fairing
8 Datalink antenna

Right: The MiG-31 main undercarriage features offset twin mainwheels on each oleo. On retraction these rotate to the vertical, in line with the oleo, then retract forwards to lie in the floor of the engine intake trunks.

allows the beam to sweep through 120° in azimuth and from 70° above the nose to 60° below. The Russians claim that this allows the MiG-31 to engage targets spread over a greater area than can its Western equivalent, the F-14, although the Western aircraft can simultaneously engage a greater number of targets. Mikoyan claims that the MiG-31 radar is capable of engaging missiles, and have referred to the aircraft as being like a Patriot missile which can fly 'repeated missions'. They also claim to be testing the weapons system against 'Stealth' aircraft. The radar also has navigation and situation monitoring functions, although navigation is more routinely handled by Marshroot (Soviet equivalent to Omega) and Tropik (Soviet equivalent to LORAN) systems, which give an accuracy of 250 m (820 ft) at a range of 2000 km (1,243 miles).

The MiG-31 was designed to operate in those areas where there is no ground-based radar coverage, such as the north, using its sophisticated onboard systems for autonomous operations. MiG-31s are most often used in groups of



9 Starboard tailfin
10 Rudder hydraulic actuator
11 Tailplane hydraulic actuator
12 Afterburner ducts
13 Ventral fins
14 Lower VHF/UHF aerials
15 Port plain flap
16 Port aileron
17 Wingtip radar warning antennas
18 Port navigation light
19 Leading-edge flap
20 Outboard wing pylon
21 R-40T (NATO AA-6 'Acrid') air-to-air missile
22 Inboard wing pylon
23 Port wing integral fuel tankage
24 Pressure refuelling connection in port wheel bay
25 R-33 (NATO AA-9 'Amos') air-to-air missiles
26 Engine accessory equipment gearbox
27 D-30F6 afterburning engines
28 Engine oil tank
29 GSh-6-23 six-barrelled 23-mm rotary cannon, starboard only
30 Ammunition magazine, 260 rounds
31 Port wing integral fuel tankage
32 Flap hydraulic jack
33 Starboard plain flap
34 Starboard aileron
35 Aileron hydraulic actuator
36 Radar warning antennas
37 Starboard navigation light
38 Leading-edge flap
39 Leading-edge flap jacks
40 Wing fence
41 Twin missile carrier/launch rail
42 R-60T (NATO AA-8 'Aphid') air-to-air missiles
43 Fuselage integral fuel tanks
44 Main undercarriage hdyraulic retraction jack
45 Pivoted axle beam
46 Asymmetric twin-wheel bogie
47 Airbrake hydraulic jack
48 Mainwheel door/airbrake panel
49 Ground electrical power connectors on port side
50 Pantographic missile carrier/launch rail
51 Pantographic hydraulic jack
52 Semi-recessed missile housings
53 Variable capture area hinged intake lip
54 Intake lip actuator
55 Variable area intake ramp doors
56 Ramp actuator
57 Upper surface spill door
58 Rear cockpit periscope
59 ECM antenna
60 Radar console
61 Weapons officer/navigator's K-36D ejection seat
62 Intake cut-back inner wall
63 Twin-wheel nose undercarriage
64 Nose undercarriage leg strut
65 Leg door mounted landing/taxiing lamps
66 Air data probes
67 Semi-retractable infra-red search and tracking (IRST) unit
68 Avionics equipment bays, port and starboard
69 Pilot's cockpit
70 Rear view mirror
71 Head-up display
72 Datalink antennas
73 Retractable flight-refuelling probe on port side
74 Total pressure sensor
75 IFF aerial
76 ZBI-16 Zaslon radar equipment module
77 Electronically-scanned phased array antenna
78 Radome
79 ILS aerials
80 Pitot head
81 MiG-31M (modifikatsirovanji or modified)
82 Refuelling probe moved to starboard side
83 Single-piece frameless windscreen panel
84 Redesigned cockpit enclosures
85 New advanced medium range air-to-air missile ('AMRAAMski')
86 Enlarged dorsal spine fairing
87 Increased area wingroot leading-edge extensions
88 Wingtip electronic warfare equipment pods
89 Enlarged fin root fairings
90 Cannon armament deleted
91 Enlarged brake parachute fairing
92 Fairing between jet pipes

Left: The pilot's cockpit of a MiG-31. The unusual turquoise background colour is common on Soviet aircraft, and was found by Russian psychiatrists to be the most restful and calming colour, allowing the pilot to operate with relaxed efficiency. The front cockpit is entirely conventional, with familiar controls and instruments in a layout which would be recognised by any MiG or Sukhoi fighter pilot, and with the standard Zvezda K-36 ejection seat. A handy white line on the instrument panel shows the pilot the central position – a useful guide when attempting to recover from a spin or any other departure from controlled flight.

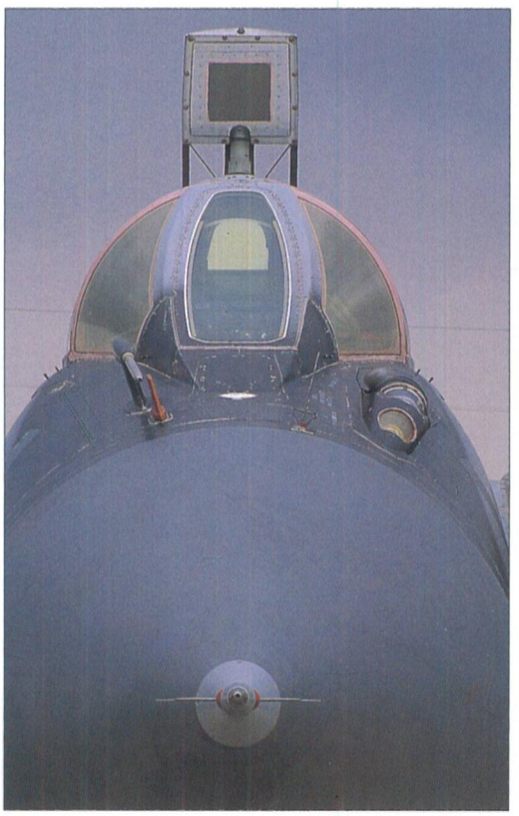
four (or even eight), linked together by datalink. Operating together, four MiG-31s can cover a strip of territory 900 km (560 miles) across, and targets can be transferred rapidly from one aircraft to another, with all aircraft sharing the same image on their tactical situation displays. The transmission of target information between aircraft by datalink reduces the vulnerability to hostile jamming, while the radar's angular tracking circuits are hard to deceive. Information denied by hostile jamming can be recovered using kinematic and triangulation methods. The aircraft is provided with secure digital datalinks to the ground (AK-RLDN) and between aircraft (APD-518). Conformal antennas for these are located respectively in the leading edges of the ventral fins and on the sides of the nose (three per side) and rear fuselage (two).

The aircraft's datalinks and powerful radar also allow the MiG-31 to act as a 'mini AWACS' in its own right, directing and controlling other fighters. The lead navigator in a flight of four MiG-31s can even directly steer his wingmen's aircraft, since their autopilots can receive his commands via datalink. Radar is not, however, the MiG-31's only target acquisition and tracking sensor. To provide an emission-free alternative to radar, or to be used in the event of radar failure, the MiG-31 is equipped with a retractable undernose IRST.

A Soviet Tomcat

If the weapons system breaks new ground, the same cannot be said for the cockpits. These contain conventional analogue instruments, and the pilot and his WSO have a very restricted view of the outside world, necessitating a faired rear-view mirror above the front cockpit, and a retractable periscope for the backseater. Dual controls seem to be fitted as standard. The pilot does have a large, modern head-up display, and the backseater has a huge central radar display and two smaller square tactical displays. These are extremely similar to the displays in the back seat of the F-14 Tomcat, lending credence to reports that the MiG-31/AA-9 combination owed much to F-14/Phoenix technology, gained from Iran after the fall of the Shah. Soviet pilots like the

Below: The bulk of the displays in the rear cockpit deprives the navigator of any view forward, and makes communication between the two cockpits difficult, except by intercom.



A head-on view of a service MiG-31, showing the semi-recessed retracted inflight-refuelling probe, deployed periscope, and windscreen configuration.

MiG-31's cockpits, which mark a major improvement over aircraft like the MiG-25 and MiG-23. By Western standards, however, they appear extremely dated.

MiG-31 reliability is equally impressive, with a claimed MTBF of 9-10 hours, compared with the F-15's five. It is, however, likely to be significantly more maintenance intensive in normal use, and is likely to have a relatively short fatigue life and short time between overhaul figures.

The MiG-31 packs a powerful punch, with a GSh-6-23 six-barrelled cannon scabbed onto the starboard rear fuselage, just aft of the main landing gear. This has a rate of fire of between 6,000 and 8,000 rpm, and fires a 200-gm shell with a muzzle velocity of 700 m/sec (2,297 ft/sec). In the MiG-31 installation 260 rounds of ammunition are carried. The gun is very much a 'last ditch' weapon, and the MiG-31's primary armament consists of four semi-active radar-homing R-33 missiles, known to NATO as the AA-9 'Amos'. Stunningly similar in size and appearance to the American AIM-54 Phoenix, the AA-9 is consistently estimated to have about the same range as the much smaller AIM-7 Sparrow, and not the 100 miles (161 km) plus capability of its US twin. This seems strange, since the Russians have always been good at rocket motor technology, and one would expect missiles of similar size to have similar ranges. The AA-9s are carried in low-drag mountings below the fuselage, with hydraulic trapezes to force them down out of their recesses when fired. The MiG-31 can also carry further missiles underwing. These can either be R-60 (AA-8 'Aphid') IR-homing short-range AAMs carried in pairs under each inboard pylon, or single R-40 (AA-6 'Acrid') missiles, which are larger and heavier, but which have

The heart of the MiG-31 lies in the rear cockpit. Rudimentary flying controls and flight instruments are provided for an instructor or to allow a backseater to take over from a wounded pilot. A huge circular tactical display is flanked by two rectangular 'raw' radar displays. Comprehensive controls allow the backseater to control the intercept or engagement, even automatically controlling other aircraft in the formation via the datalink, allocating target priorities, and co-ordinating defensive systems. This enormous responsibility and high cockpit workload make the rear cockpit of the MiG-31 a highly sought-after assignment for the ambitious young PVO officer.

longer range. An IR-homing R-40T would normally be carried under one wing with a semi-active radar homing R-40R under the other. These could then be ripple-fired to maximise kill probability. Alternatively, an R-40 can be carried on one inboard underwing pylon, with a pair of R-60s under the other. Outboard underwing pylons are seldom fitted (except on later production MiG-31s), but these can be used for the carriage of further R-60s or external fuel tanks. With a full weapon load and external fuel the MiG-31 grosses more than 100,000 lb (45360 kg), equivalent to a pair of Canberras or three AV-8Bs. In order to reduce landing distances a pair of brake chutes is therefore stowed in the rearmost part of the spine fairing.

Product 5

The original model has had its shortcomings, which have become more obvious with the passage of time. An improved MiG-31, the MiG-31M, had been planned from the start, and work began on the new variant in about 1978, under the in-house designation 'Product 5'. Designed under the direction of Edward Kostrubskii, the new variant introduced avionics and aerodynamic changes. Little is known about the early history of the MiG-31M, although details have emerged concerning the loss of the first prototype on 9 August 1991. While being flown from the Zhukovsky flight research centre (traditionally but erroneously known in the West as Ramenskoye), a mechanical link in the aileron control circuit failed. The pilot, Vladimir Gorbunov, a senior inspector of the Ministry of Aircraft Industry, experienced a progressive uncommanded roll to port, which he was able to counter with full starboard rudder and full starboard aileron. Lowering the undercarriage, Gorbunov carried out a low-speed handling check and a dummy approach and landing at 3000 m (9,823 ft). He decided that it would be possible to land the aircraft, and set himself up to land off a straight-in approach. During the final approach, however, at less than 30 m (98 ft) altitude, the aircraft began to yaw and roll from left to right and back, before the troublesome aileron travelled even further from neutral. This time even full stick and rudder deflection could not stop the roll to port. Gorbunov selected military power to go around, and the aircraft flew along the runway at about 90 m (295 ft), slowly rolling to port. As the angle of bank reached 90°, Gorbunov realised that he would need to abandon the aircraft, but feared that to do so at that instant could result in the stricken aircraft ploughing into apartment blocks on the airfield boundary and a possible ejection outside the seat parameters. He therefore pushed the stick hard over to the left to complete a roll to the inverted position and then pushed into an inverted climb. As the aircraft rolled level again he pulled back on the stick to gain more altitude. When clear of the built-up area he and his navigator ejected safely.

The familiar Mikoyan demonstrator gained patriotic Russian white, blue and red rudder stripes for its appearance at the 1992 Farnborough SBAC show. The aircraft remained on static display for most of the Farnborough period, but did fly a couple of surprisingly energetic displays.

The first information on the MiG-31M

Right: The Mikoyan demonstrator is believed to be based at Zhukovsky near Moscow, home of the Gromov Flight Research Centre. It is seen here on one of the Zhukovsky flight lines, in company with test aircraft which include Tu-16 'Badgers' and even a Tu-144 'Charger'.

The pilot's viewpoint

Colonel Vladimir Ivlev is a 48-year-old PVO veteran, who has spent most of his career flying MiG fighters in the air defence role. As a young MiG-21 pilot he was deployed to Egypt with his regiment and took part in the famous 30 July 1970 engagement with the Israelis, during which five MiGs were lost. Ivlev claimed to have damaged an Israeli Mirage, which left the fight streaming fuel vapour. This was almost certainly the aircraft flown by Asher Snir, who had to force-land at Refidim after his wing tanks were holed. Almost 10 years later Ivlev, now flying the MiG-25PD, was deployed to cover the invasion of Afghanistan.

"My first contact with the MiG-31 was during the mid-1980s at the Flight Test Research Institute in Zhukovsky airfield, south-east of Moscow. Although this potent fighter had attained initial operational capability about two years earlier with a PVO operational test and evaluation squadron, I was posted there to gain experience in its new and advanced systems prior to being assigned to a regiment in the north due to re-equip from the older Su-15. I arrived several months after the death of Mikoyan's chief test pilot Alexander Fedotov and his navigator Valery Zaisev in the crash of a development MiG-31.

"If we compare the MiG-31 operational requirement with that of the MiG-25, we could find out that both were quite alike, with a difference. In the 15 years that separated the designs of both, the electronics systems have evolved in such a way that the mission parameters had dramatically widened. The main requirement for the future MiG-31 was that it could be able to destroy hostile targets at low or high altitude thanks to its detection and fire capabilities in the forward, rear sectors but especially in the lookdown area, under any weather conditions, even if the adversary uses evasive manoeuvres or electronic countermeasures.

"During the initial stages (from 16 September 1975, date of the first flight) the prototype was known as the MiG-25MP. According to the PVO official requirement, it wasn't necessary for the new interceptor to be faster than the MiG-25 series; on the contrary, it should have more range and endurance, to which the D-30F turbofans contributed, each rated at 152 kN in maximum thrust.

New capabilities

"For me, with quite an experience level in the MiG-25P/PD, the MiG-31 seemed a new aircraft. Firstly it was a tandem two-seat, the new weapons systems made necessary that a navigator-radar officer should be installed in the rear cockpit. The airbrakes were fitted in a new position, between the main landing gear and the air intakes. The main landing gear was substantially modified, each leg being fitted with two wheels ingeniously offset in order to operate effectively from snowed, iced and non-prepared surfaces. Ailerons and flaps occupied the entire wing trailing edge.

"Some of the test flights associated with its operational capabilities, in which I did participate, comprised missions over the far north of the then Soviet Union, evaluating the new navigation system in an area where important magnetic anomalies take place. Some very long-range missions to the Union's Far East took place (with the aid of air-to-air refuelling); even the North Pole was overflown. Thanks to these and previous tests the MiG-31 incorporated new manoeuvring flaps along the full span of the wing's leading edge, comprising four sections for each half wing. Another novelty was the leading edge extension, and as it had low-level supersonic capability the wing structure was reinforced with the addition of a third spar. A semi-retractable refuelling probe was fitted on the left side of the nose.

"The MiG-31 operational capabilities are intimately associated to its new weapons system which comprise three main elements: a ZBI-16 Zaslon phased array radar (the first and the only so far fitted to a fighter) with excellent lookdown capability; a retractable IRST system fitted under the front fuselage; and a tactical situation display in the rear cockpit. The radar's range in acquisition-pursuit in lookdown is 150-200 km in the forward sector and 70-90 for the rear sector. Ten hostile contacts can be tracked at the same time, of which four can be engaged at the same time. The simultaneous pursuit-shooting angle is 70° in azimuth and 60-75° in elevation. As in a fighter of these characteristics, navigation was of paramount importance and redundant systems were fitted, a Tropik LORAN and a Marchroot Omega.

Diversified armament

"As a pure interceptor, capable of engaging aerial targets - both aircraft and cruise missiles – at any height, the MiG-31 has a much more diversified armament than its predecessor, the MiG-25, comprising four radar-guided long-range R-33s under the fuselage and two infra-red guided R-40s on wing stations, or four R-33s and four short-range R-60s on double launchers, or two R-60s and two 2500-litre drop tanks. To complement the missiles for close-in engagements the MiG-31 was fitted – another novelty – with a GSh-6-23 gun with 260 rounds, situated on the side of the right intake trunk, just behind the landing gear.

"For its role, the MiG-31 is an excellent fighter. Of course, it was not designed for fighter-versus-fighter combat, and although low-speed, high angle-of-attack manoeuvres are not recommended in the procedures manual it is very fast, has very long legs (with or without air-to-air refuelling) and climbs like a rocket.

"After almost a year at Zhukovsky I went, as a full colonel, to the MiG-31 regiment based near Arkhangelsk (the 250 MiG-31s delivered so far have re-equipped five VPO interceptor regiments – mine, and others in or near Murmansk, Moscow, the south and the far east), where I took charge of the Combat Readiness Department, responsible for the development of tactics, etc. for our intercept mission. Unfortunately, this job occupies me in such a way that I can't fly as much as I wish, although none of my pilots and navigators fly as much as they would like due to the acute fuel and spares shortages. We in PVO are in a better situation than the VVS, especially the Long Range Aviation. Usually a senior pilot flies some 90-100 hours per year, while a junior pilot logs between 100-120, depending on the units and the importance of their mission. Until April I had logged slightly more than 2,600 flight hours, almost all of them in products of the Mikoyan Design Bureau.

"In what concerns the combat tactics and operational operating procedures, these comprise four main modes, aided by automatic GCI stations and the Ilyushin A-50 early warning aircraft: long-range interceptions under close control of the A-50; semi-autonomous with a minimum of contact with ground-based or airborne early warning radars; 'lone wolf' intercepts with a singleton MiG-31; and, finally, 'wolfpack' intercepts, which comprises a formation of four MiG-31s which constantly exchange information via datalink. On this tactic the flight leader MiG-31 is the only one who maintains contact with the GCI stations and/or the A-50, flying roughly line abreast with the other three aircraft, with a distance between each one of some 200 km so that the distance between the left wingman and right wingman is 600 km. In that way the overlapping ZBI-16 radars cover an arc of some 800-900 km. An APD-518 datalink system allows the flight leader and his three wingmen to continuously and automatically maintain an exchange of information, providing solutions to the pursuit, search and co-ordination of the four-ship formation. Distribution and assignment of the targets is made by the flight leader, whose navigator/radar officer is the mission commander, according to the information provided by the tactical situation display.

"Recently, the MiG-31M was certified by PVO as a combat capable machine. This improved version has a 'glass cockpit' and augmented capabilities on its radar but I have my doubts if it will ever be built in any numbers, due to the economic crisis and the changed world situation. Perhaps, and if shrinking budgets allow, some early MiG-31s could be retrofitted to this standard. What is certain is that the Voyska Protivovozdushnoy Oboroni is going to be radically trimmed during the coming years. Until very recently it possessed the largest manned interceptor force the world has ever seen. I'm very proud to have served on it for almost 25 years, a full career in which I almost exclusively flew MiG-21s, MiG-25s and MiG-31s, but which also included a one-year posting to a VPO MiG-23 regiment at Sakhalin in the Far East, keeping a close watch on American electronic surveillance flights, but that is another story."

Standing in front of a MiG-31 are (left to right): Major Mikhail Gorbunov (RIO), Lt. Col. Vladimir Gurkin (pilot), Salvador Huertas (Spanish photographer), Lt. Col. Alexander Kutosov (pilot of MiG-29 chase aircraft) and Vladimir Ivlev.

Colonel Vladimir Ivlev is an exceptionally experienced PVO fighter pilot and had previously flown the MiG-21, MiG-23 and MiG-25, but found flying the new aircraft a completely new experience, mainly by virtue of its greatly improved capabilities.

Above: Although it retains the same basic configuration of the MiG-25, the 'Foxhound' is in every respect a new aircraft, with a very different role and a new level of capability. Absolute flat-out top speed is slightly reduced, but handling is improved over a wider envelope, and many relevant performance parameters are increased, including ceiling and acceleration.

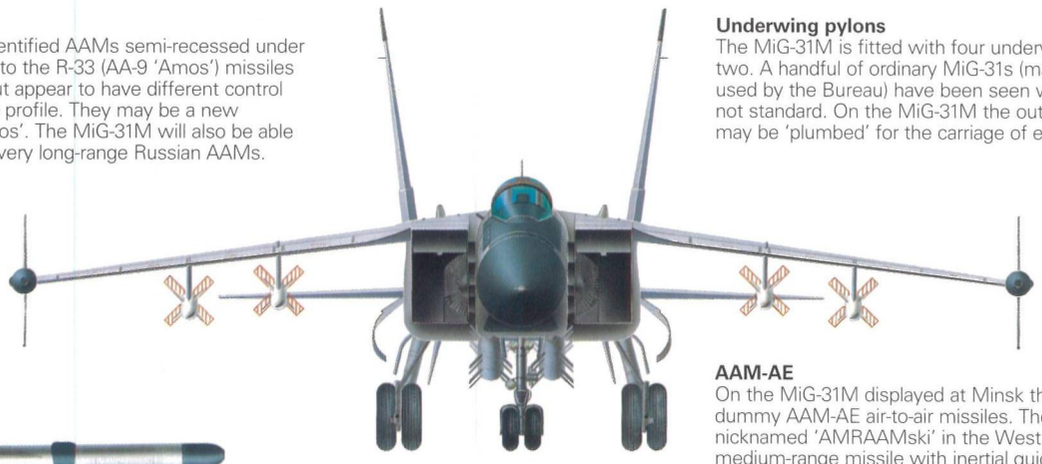
Right: Despite considerable efforts and an excellent aeroplane, Mikoyan has been unable to win any export orders for the MiG-31. Valery Menitsky (seen here) has proved as hard-working a salesman as he is a test and demonstration pilot, but so far without result.

appeared in 1990, as an offshoot of the CFE talks (the original MiG-31 being a treaty-controlled item). Top-side, front and side view photos of the third prototype, 053, were released to the appropriate authorities, but none saw the light of day in any open-access publication. A great deal of information leaked out in the USA, however, and this allowed an artist's impression and brief description to be published in the addenda to the 1991-1992 *Jane's All The World's Aircraft*. A very poor quality underside view of another MiG-31M was published in Poland during 1991, although the aircraft shown had non-standard rod-like pods which extended horizontally back from the wingtips.

Better photographs became available during early 1992, after the big display of advanced Soviet aerospace programmes for CIS leaders at Minsk-Maschulische, where the seventh MiG-31M, coded '057', made the type's public debut. Photographers were reportedly told not to photograph certain exhibits, including the MiG-31M, but the ITAR-Tass news agency didn't get the message and published a single photo, also allowing the aircraft to appear in the background of another picture. These gave a much clearer idea of the new aircraft's appearance. The same aircraft was also clearly visible, though not photographable, in the background at the 1992 Moscow Aeroshow at Zhukovsky. Its non-appearance in the flying and static display was explained as being due to the fact that the aircraft was 'still secret'.

Aircraft '057' did display many of the features previously attributed to the MiG-31M. The fuselage spine was completely recontoured, with a higher horizontal top line and a fuller cross-section. This bulged spine is understood to contain both avionics and fuel. The aircraft also features extended chord, curved, leading-edge root extensions, ('Sabres' in Russian parlance), which were added in an effort to improve the aircraft's poor high alpha handling. (In another effort to counter this perceived deficiency an angle of attack meter was added, with a probe on the side of the nose.) Although the MiG-31 was never intended as a dogfighter, the high angle of attack handling did present a serious problem, sufficent to be openly criticised by Soviet test pilots in the Russian aeronautical press, and responsible for a number of accidents. Mikoyan clearly believes that agility is the way of the future and has described the aircraft as the last aerodynamically stable fighter they will produce. In fact the MiG-31's hydraulically boosted flight controls are backed up by a 'clever' autopilot which enhances stability and handling. Visibility for the pilot was enhanced by the addition of a single-piece curving windscreen, and by the provision of a 'roofless' cockpit canopy. The backseater's

Primary armament
This MiG-31M carries four unidentified AAMs semi-recessed under the fuselage. These are similar to the R-33 (AA-9 'Amos') missiles carried by standard MiG-31s, but appear to have different control fins and a more 'rounded' nose profile. They may be a new version, perhaps an 'Active Amos'. The MiG-31M will also be able to carry the new generation of very long-range Russian AAMs.



Underwing pylons
The MiG-31M is fitted with four underwing pylons, instead of only two. A handful of ordinary MiG-31s (mainly development aircraft used by the Bureau) have been seen with four pylons, but this is not standard. On the MiG-31M the outboard underwing pylons may be 'plumbed' for the carriage of external fuel tanks.

AAM-AE
On the MiG-31M displayed at Minsk the underwing pylons carried dummy AAM-AE air-to-air missiles. The AAM-AE has been nicknamed 'AMRAAMski' in the West, and is believed to be a medium-range missile with inertial guidance and terminal active radar homing. This gives true 'launch and leave' capability. The control fins are of novel design, with a grid of aerofoils set within a rectangular box. Believed to be based on fins designed for the SS-21 'Scarab' and SS-23 'Spider' ballistic missiles, these lightweight control surfaces require less deflection for a given manoeuvre and use less powerful actuators. The fins are particularly effective at high speeds or at high angles of attack.

Undercarriage doors
The MiG-31 has new nose undercarriage doors on each side of the nosewheel bay, and with no front door mounted on the nose oleo. Landing and taxi lights are now mounted directly on the oleo.

Sabres
Poor high α handling was always a problem with the MiG-31, and huge, curved leading-edge extensions have been added to the MiG-31M in an effort to improve handling characteristics at high angles of attack.

Mikoyan MiG-31M

The aircraft shown here is the seventh prototype Mikoyan MiG-31M. Known internally within the Design Bureau as the Product 05, the prototypes wear three-digit codes consisting of the numbers '05' followed by the sequential identity of the airframe. Because the aircraft remains cloaked in secrecy, little is known about the MiG-31M programme, and even its appearance was a mystery until photographs were mistakenly released by the ITAR-TASS news agency. It is widely believed that the MiG-31M is unlikely to win its battle for production funding, despite its effective new weapons system, armament and avionics, unless a risk-sharing foreign customer can be found. India and China are both believed to have expressed an interest in the aircraft at different times, but whether or not such interest can be transformed into orders is quite another matter.

Wingtip ESM pods
At least the seventh MiG-31M is fitted with streamlined cylindrical ESM pods, with radomes forward, aft, and on the outer side. The pods also mount large cropped triangular vertical fins, which may serve as aerials of some sort, or as aerodynamic 'winglets'.

New canopy
In an effort to improve visibility for the pilot, the MiG-31M is fitted with a single-piece wraparound windscreen and a new one-piece 'roofless' canopy.

Inflight-refuelling probe
While early MiG-31s completely lacked any provision for inflight refuelling, later aircraft were fitted with a semi-retractable probe on the port side of the forward fuselage. This was semi-recessed when retracted. The MiG-31M has a neater, fully-retractable probe on the starboard side.

Tailfin changes
The tailfin trailing edge is cut away below the rudder, and the leading edge fairings from the fin to the fuselage appear to be reprofiled.

Left: A Mikoyan model shows a little-seen option: underwing auxiliary fuel tanks outboard of the missile pylons. The MiG-31's exceptional internal fuel capacity and economy ensures that internal fuel is sufficient for most missions.

Right: For close-in work the MiG-31 is fitted with a six-barrelled 23-mm cannon. It can carry 260 rounds of ammunition for this weapon.

Instead of pairs of AA-8 'Aphids' the MiG-31 can carry a single R-40 (AA-6 'Acrid') under each or either wing. IR-homing or semi-active radar-homing versions of the missile can be carried, providing a medium-range complement to the newer, long-range 'Amos'.

side windows have been reconfigured, and the windows between the two cockpits (which were virtually blocked by equipment anyway) have been removed altogether.

New missiles

Like many late-production MiG-31s, the MiG-31M seems to be fitted with four underwing pylons (although the aircraft illustrated in Poland only had two). On the aircraft at Minsk, these carried the new PBB-AE (rendered from Cyrillic as RVV-AE) missile. The alternative acronym AAM-AE is used in English. Dubbed 'Amraamski', the new air-to-air missiles, for which no NATO designation is yet known, are described as 'launch and forget' air combat multi-mission missiles. If these require illumination, it would support the view that the MiG-31M has a new radar, since the existing 'Flash Dance' is unlikely to be compatible with such a new weapon, which is also carried by the MiG-29M. Soviet sources describe the new weapon as being an 'active rocket' but this may only infer the use of active terminal homing, with semi-active initial guidance. Rumours suggest that problems with the MiG-31M's new radar, developed by Fazatron, delayed the aircraft's 'preliminary conclusion' by over a year. The MiG-31M has never been seen carrying the distinctive 30-mm gun pod on the starboard rear fuselage, and may also have a new long-range missile armament. At Paris, Mikoyan was tight-lipped about the MiG-31M, but did infer that it would be armed with an active radar-homing missile. The aircraft at Minsk carried four large missiles under the fuselage, but these seemed to differ slightly from previously-seen examples of the AA-9 'Amos', with rounder noses and a different control fin configuration. This may have been some kind of 'Active Amos'. Recent reports have also suggested that the MiG-31 can carry a brace of ultra-long range AAMs, possibly for the ASAT (anti-satellite role), or possibly for anti-AWACS duties. A variation of the same report suggests that such a missile is carried singly on the centre-line.

Left: The R-60 can be carried in pairs under one or both wings. Dubbed AA-8 'Aphid' by NATO, the R-60 is a short-range agile dogfight missile whose 6-kg warhead includes an astonishing 1.6 kg of uranium. Later versions of the missile are believed to have all-aspect capability.

Wingtip pods

New to the '057' were a pair of wingtip pods, presumably housing ESM/ECM equipment, similar in size and shape to those fitted to the Su-27 attack variant illustrated in *World Air Power Journal* Volume 9. They seem to feature front and rear dielectric panels and a number of other smaller protuberances. These pods differ, however, in having prominent vertical fins above and below their rear ends. Other details not previously noted include a fully-retractable inflight-refuelling probe, which has been relocated from the port to the starboard side of the nose. At Moscow Aerospace similar wingtip pods (shorter and without fins, but with rod-like antennas projecting aft) were seen on a standard MiG-31, and may be adopted in service, although the fully-retractable refuelling probe remains a MiG-31M only item. The undercarriage of the MiG-31M also differs slightly, with a pair of sideways-hinging nosewheel doors replacing the side and front doors of earlier aircraft. The

Above: The primary long-range armament of the MiG-31 is the R-33, a huge semi-active radar-homing missile (possibly with an inertial and active terminal homing mode) and which bears a striking resemblance to the AIM-54 Phoenix.

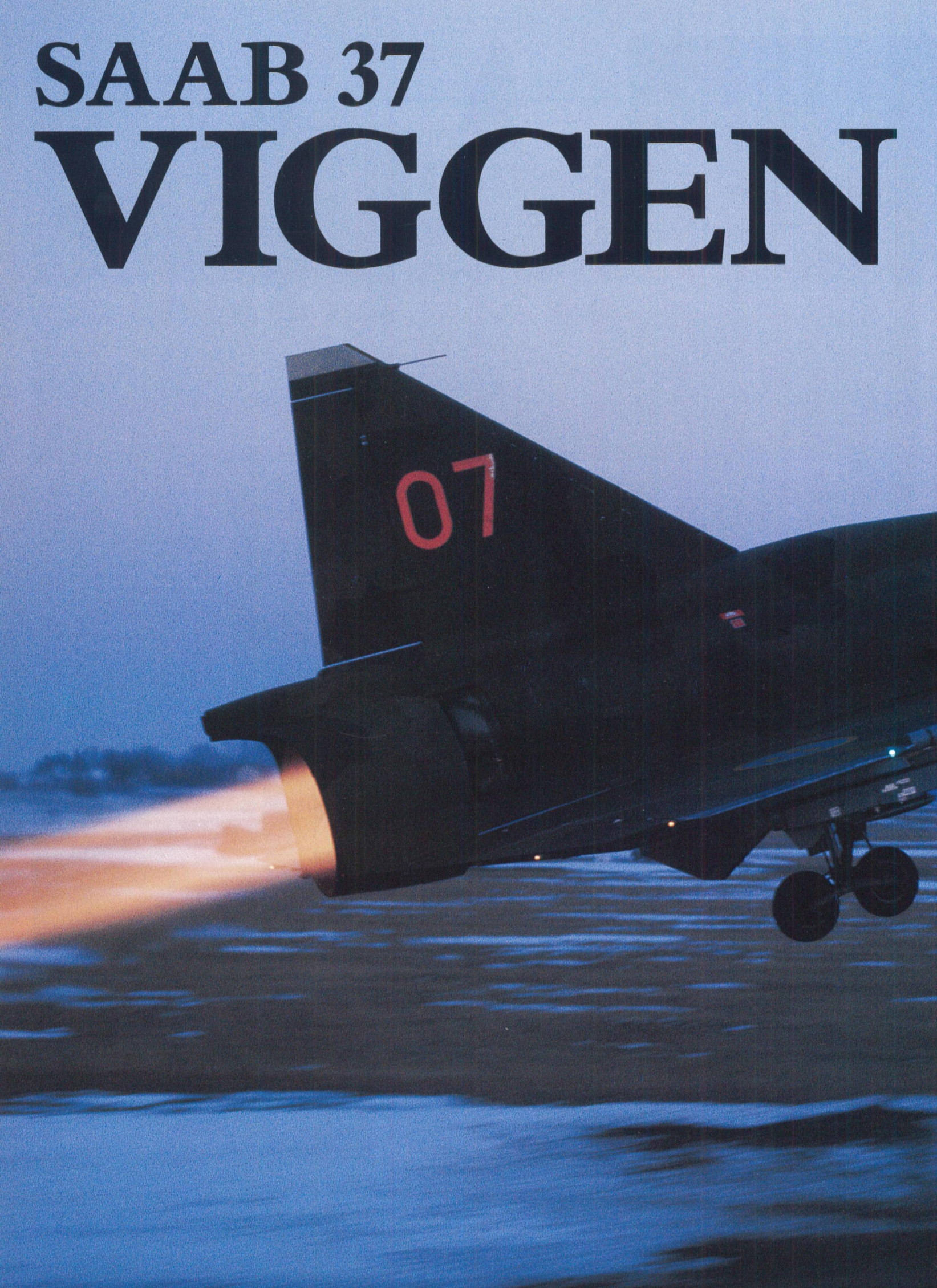
landing and taxi lights which were previously mounted on the forward facing door have been relocated on the nose gear itself. Various aerials and other protrusions have been deleted or moved, for example the prominent pitot above the nose on the MiG-31 has been relocated below the starboard side of the pilot's canopy.

At Minsk, the MiG-31M was described as not being a 'core programme', and production funding seems unlikely to be granted. However, Indian interest has often been reported in the basic 'Foxhound' and the country could be a possible production partner and launch customer for a 'private venture' MiG-31M development, if security considerations relating to the new weapons system permit. Whatever the future holds for the MiG-31M, the 'ordinary' MiG-31 will remain a vital link in Russia's air defences for many years to come.

The current status of the MiG-31M remains uncertain, but the end of the Cold War, the dissolution of the USSR and technical problems have conspired to make production seem progressively less likely. The MiG-31M has aerodynamic refinements, a new radar and a new defensive avionics system, with wingtip ECM pods.

Left, below, and inset below: The wingtip pods on this MiG-31 are believed to house cameras for filming missile launch trials and telemetry equipment, and may not be ECM or ESM pods, unlike those on the MiG-31M. The significance of the lion insignia on the engine intakes is unknown.

SAAB 37
VIGGEN



While larger European countries will only undertake major military aircraft programmes in collaboration with equally powerful partners, Sweden has maintained a tradition of designing and building its own indigenous combat aircraft. Non-aligned and vigorously neutral, Sweden is able to procure aircraft tailored to its own particular requirements, avoiding undue reliance on foreign suppliers and saving hard-earned foreign currency. Remarkably, many of Sweden's indigenous fighters have proved extremely effective, with performance characteristics and operational capability which stand comparison with the world's best. Although its designated replacement is now flying in prototype form, Saab's Viggen remains the backbone of Sweden's air power, ensuring that the price of aggression against Sweden continues to be unacceptably high.

Main picture: A Saab AJ 37 Viggen of F6 thunders into the air from Karlsborg's icy runway. The Viggen's single JT8D (known locally as the RM8A) produces plenty of thrust, but is rather 'thirsty', and many consider that the Viggen is deficient in range as a result.

Inset below: The Viggen's huge canard foreplane generates tremendous lift, and endows the fighter with an excellent short take-off capability. The canards themselves are fixed, but are fitted with trailing-edge flaps which can be deflected up or down.

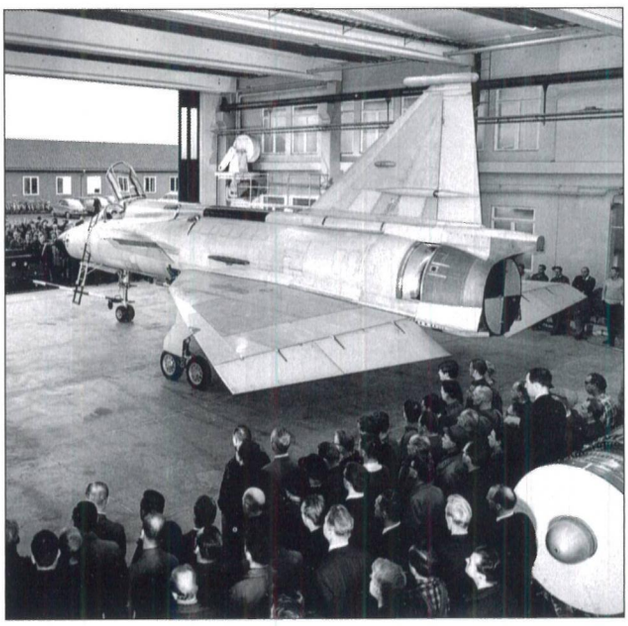
Specific problems demand specific answers, and to the question of how might Sweden's neutrality best be defended from the air, the most specific reply possible is 'Saab Viggen'. Indeed, so closely tailored was this machine to the defensive strategy of its homeland that its prospects for export sales were seriously, perhaps fatally, weakened. Some might charge the Viggen's designers with 'gold plating' the aircraft, but that would be to discount the tradition of strongly armed neutrality maintained over nearly two centuries by the government in Stockholm. Sweden is prepared to pay the financial price for escaping the ravages of war and if the best equipment for the job is not to others' liking, there is no question of weakening national defence in order to make local armaments more attractive to outside buyers. In any event, Sweden will not sell weapons to all comers, just as it tries as hard as possible not to be reliant on others for defence equipment. That means building its own and not taking military aid from any other country or alliance.

Before proceeding, it is as well to pause to consider the enormity of the task which confronted Saab in particular, and Sweden in general, when the Viggen was conceived and developed. Were New York to announce its intention of producing from scratch a combat aircraft with many new and advanced features, the general view would be that the city fathers had taken leave of their senses, yet, in terms of effort per head of the population, the magnitude of the undertaking exactly mirrors the challenge Sweden set itself. Despite a population of only 8 million, this Nordic kingdom must defend an area the size of Germany and Hungary combined, and which encompasses considerable variations in topography and climate over its 978-mile (1574-km) north-to-south stretch. The national policy of 'total defence' involves considerable reliance being placed upon reservist forces and dispersal of air units from fixed bases to a larger number of auxiliary strips. In short, as well as being one of the most effective and versatile combat aircraft in the world, the Viggen had to be simple enough to be serviced by conscripts and sufficiently rugged and powerful to operate from short stretches of road, perhaps north of the Arctic Circle.

Thoughts on providing a follow-on to the revolutionary Saab 1250 Draken (official designation Flygplan 35 – Aircraft 35) were first stimulated in May 1952, or well over three years before the double-delta took to the air. Leading force was Erik Bratt, whose team at Linköping first studied an attack aircraft to take over from the Saab 32 Lansen. A series of projects in the 1300-series included fighter-bombers with two wing-mounted jet engines, for which the de Havilland Gyron Junior was considered. Of passing note, the Saab 1357, conceived in October 1954, was the first to explore the use of canards, being an extension of the T-tailed Project 1338 which resembled Britain's contemporary Bristol 188 research aircraft, except that it had what would now be called LERX (leading-edge root extensions).

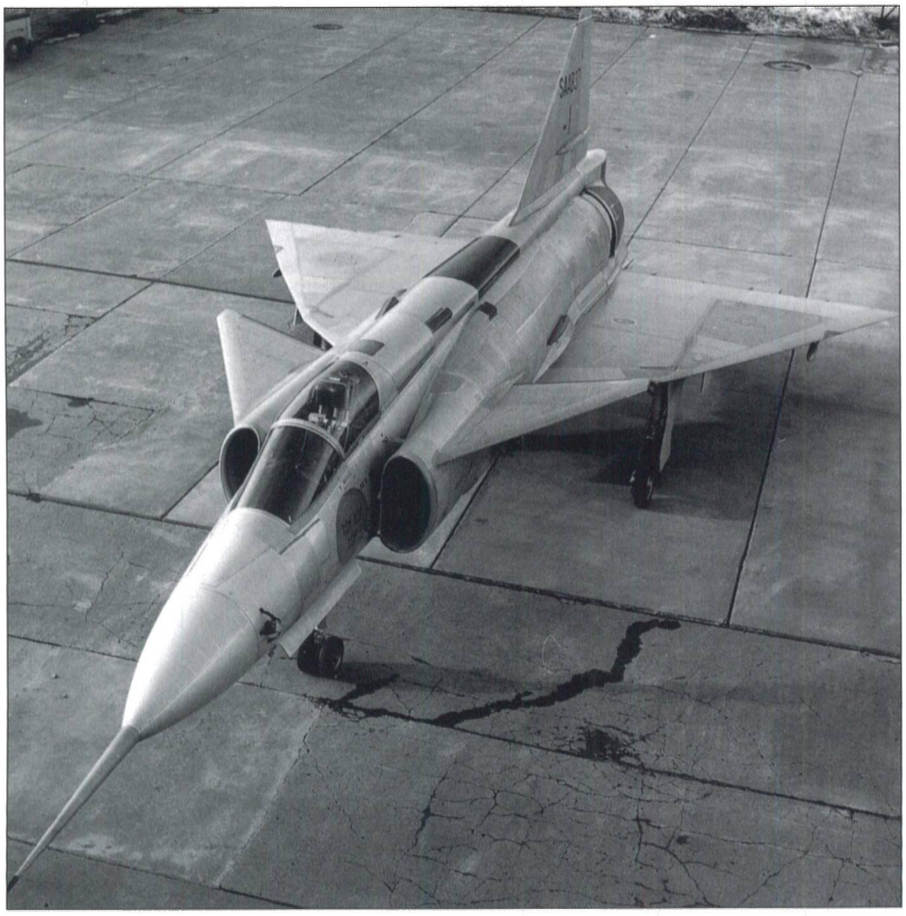
More promising of an immediate order was the Saab 1350 attack version of the Draken interceptor which almost was adopted with the service designation of A 36. Further along this road was the 35-Olympus: an enlarged Draken powered by the massive Bristol Siddeley Olympus 22R. The prospective A 36 failed to translate into metal when the air force set its sights on a multi-role machine to replace both the Lansen for attack and (at a later stage) the Draken interceptor. Destined to become Fpl 37, the new aircraft was the subject of Saab studies in the 1500 series. Marrying the STOL requirements of off-base operations with the early 1960s European enthusiasm for VTOL, the 1508 project of March 1961 strongly resembled a canardless Mirage 2000 powered by a single 18,520-lb (8400-kg) thrust Rolls-Royce RB168 Spey reheated turbofan, but with two 4,400-lb (2000-kg) thrust RB162 lift-engines ahead of the cockpit, directed downwards. Operating in conjunction with full downward elevon, the mini-engines were intended to reduce the high landing speed associated with deltas of the period. However, further investigation revealed that jet downwash would have produced control problems when in ground effect, and this novel approach was therefore abandoned.

The 30,400 lb (13800 kg) of thrust (with 33,075 lb/15000 kg in prospect) provided by the reheated Olympus 22R was a powerful attraction for Saab, which returned to this engine for several studies, culminating in the 1561-1563 series of September 1961. Similar except for their examination of different wing shapes, they included the 1563, a large, slim aircraft, which would be recognisable today as a 'stretched Viggen'. Four types of turbofan had been under consideration for local production to power Aeroplane 37, of which the transatlantic contenders were both from Pratt & Whitney: the JT4-29 and JT8D-22. Military versions of the



Right: Rollout. The prominent fairing on the fintip was extremely short lived, and housed a camera for recording airflow over the wings, which were fitted with woollen tufts.

Below: As originally rolled out, the first Viggen prototype had considerable dihedral on the canard foreplanes, and the trailing-edge flap was to have incorporated blowing.



Above: The Viggen prototype seen in flight. The aircraft wore a Viggen and thunderbolt badge on the air intake, and was fitted with a long test instrumentation boom on the nose. It seems that the dihedral canards and fin-tip fairing were removed after tunnel testing, and were never flown.

Left: Probably pictured during its maiden flight, on 8 February 1967, the first Viggen is seen with its distinctive undercarriage down. Pilot on the first flight was Erik Dahlstrom.

JT4 powered the USAF's Republic F-105 Thunderchief and Convair F-106 Delta Dart, whereas the JT8 was specifically designed for Boeing's 727 airliner.

On 2 December 1961, the Försvarets Materielverk (FMV – Armed Forces Material Administration) ruled that the JT8D should be the Fpl 37's powerplant, resulting in Svenska Flygmotor obtaining a licence on 28 May 1962. Slightly scaling-up an earlier design, the Spey-powered 1504B, Saab submitted the resultant Project 1534 for official approval in February 1962 and was rewarded on 28 September by its formal acceptance as the next combat aircraft for Kungliga Svenska Flygvapnet (The Royal Swedish Air Force). Usually abbreviated as Fv, the air force dropped its 'Royal' title in 1974. (Language purists may wish to note that the definite article is indicated by an 'et' (masculine/neuter) or 'en' (feminine) suffix in Swedish; therefore, Flygvapen is 'air force', but Flygvapnet is 'the air force'.)

Futuristic design

Information on Fpl 37 was first made public in December 1962, when the novel wing configuration generated considerable interest. The detailed design was only then being frozen (for example, it was decided during the same month to reduce the fuselage length by 3.2 ft/1.00 m). It would be going too far – but only just – to describe the Viggen as a biplane, yet the lift contributed by the foreplane is significant in the achievement of short-field performance. As the first canard-equipped military aircraft to enter production since aviation's stick-and-string days, the Fpl 37 was clearly an innovation. That said, its futuristic lines should not be confused with the later generation of foreplane-equipped fighters, such as the Saab JAS 39 Gripen and Dassault Rafale, whose external appearance indicates reliance on a fly-by-wire computerised control system, the so-called 'relaxed stability'.

Far left: Armed with a pair of rocket pods underwing, the prototype Viggen takes off after an impressively short roll. This aircraft was later used for spin tests, with its nosecone painted red and black, and a black port fin surface.

Above: The second and third prototypes pose during weapons trials. No. 2 carries the Rb05 missiles under the engine intakes, and M70 rocket pods underwing, while No. 3 carries ECM pods inboard and chaff/flare dispensers.

Right: The Saab test fleet, minus aircraft No. 5, is away at the Försökcentralen. No. 4 (unpainted) crashed one month later, on 7 May 1969. No. 1, furthest from the camera, has been retrofitted with the reprofiled fuselage spine, bulged ahead of the fin to improve transonic longitudinal stability.

Flaps on the canard's trailing edge, acting in unison with, or in opposition to, flaps and elevons at the rear of the wing, allow the Viggen to evade the high landing and take-off speeds which characterised contemporary deltas such as the Dassault Mirage III.

The Viggen met with ease the strict FMV specification of combat operations from 1,640-ft (500-m) runways, performance few other of the world's attack jets could equal. With foreplane flaps deflected downwards, and full afterburner, the Viggen leaps into the air after a short take-off roll of some 1,310 ft (400 m). In flight, it meets the low-level attack criteria of stability and low gust-response while handling within the abilities of the average pilot. Short landing demands are satisfied by a steep approach with nose raised 15.5° but at the commendably low speed of 121 mph (195 km/h) which is maintained by an auto-throttle to within 6 mph (10 km/h). An AIL-designed microwave Tactical Instrument Landing System (TILS) installed at all Fv bases presents the pilot with a touchdown aiming point in his HUD so that the maximum amount of runway is available for roll. Arrival on the ground at about 109 mph (175 km/h) is euphemistically described as 'firm', following which a blast of reverse thrust and application of anti-skid brakes brings the aircraft swiftly to a halt in about 1,475 ft (450 m). Significantly, the Viggen was the first aircraft to be equipped with both afterburner and reverse thrust.

A hefty outward appearance belies the fact that the Viggen's airframe is commendably light for one stressed to +12g, as the result of imaginative use of honeycomb panels and metal bonding. The fuselage is of all-metal construction, employing light forgings and heat-resistant plastics bonding, plus titanium in areas exposed to high temperatures, such as the engine fire-wall. Wings and fin similarly use honeycomb structures for control surfaces, the vertical surface having a hinge just above the fuselage so that the entire fin can be folded to port when the aircraft is stowed in low-ceilinged dispersal buildings. This done, the aircraft's height is reduced to 13 ft 1.5 in (4.00 m) from the upright 18 ft 4.5 in (5.60 m).

Sturdy Motala Verkstad landing gear can accommodate a sink rate of up to 16.4 ft (5.00 m) per second, making possible the hard, no-flare landings necessary for short-field operations. The steerable, twin nosewheels retract forwards to lie under the pilot, while the allied requirements of low wheel loading and restricted stowage space in the thin wing have dictated tandem wheels on the main legs, the oleos of which contract during the retraction cycle to occupy a shorter length. Related benefits are that the tandem arrangement better absorbs the landing shock and offers less drag when taxiing in snow.

Conscript maintenance

Care has been taken to make the Viggen easy to service between flights, so that a high sortie rate can be maintained during hostilities. Important considerations are that half of the Fv's personnel are conscripts who have only 10 months to learn their duties, following which they attend three-week exercises every few years up to the age of 47. In wartime, 80 per cent of military personnel will be reservists. For these reasons, the Viggen is covered with over 100 easy-access panels to internal equipment, including a forward-sliding radome around the radar, and provision for the rear fuselage to be removed for a rapid engine change.

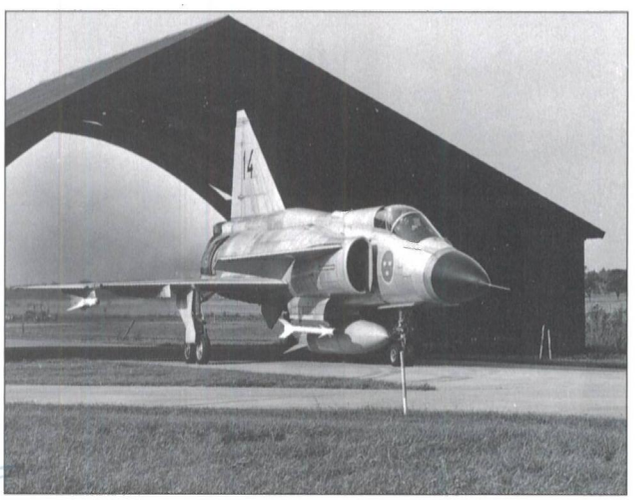
Protected by a windscreen capable of withstanding a 2.2-lb (1-kg) birdstrike at 621 mph (1000 km/h), the Viggen's pilot sits in a Saab-designed ground-level rocket ejection seat surrounded by an uncramped cockpit. The forward view includes a Svenska Radio/Ericsson HUD with self-regulating brightness, providing the usual data for navigation and attack. One difference from equipment in other air forces' aircraft is that there is a further mode for displaying data from the TILS landing aid. Central on the instrument panel is the circular Svenska Radio-designed radar display, which may be used for attack or navigation. Like the HUD, this can be programmed to present flying data so that the pilot need not monitor two displays when working head-down.

Swedish self-sufficiency in production of the Viggen has extended to the unusual lengths of spurning Martin-Baker in favour of a locally-developed rocket ejection seat designed by Saab. The first-generation seat was initially tested (by a dummy) at Linköping in May 1975 from the back of a truck travelling down the runway. When all practicable speeds above the minimum of 47 mph (75 km/h) had been explored, the next step was to fit the seat in the rear of the Saab-operated Lansen fighter version (J 32B) second prototype 32502 for surface and airborne testing at higher speeds. Known as the '32 Beta', 32502 made its first test at Linköping on 17 March 1966, simulating a runway ejection at 109 mph (175 km/h), and completed a further 36 flying tests between 171 and 705 mph (275-1135 km/h) before March 1969. In the most exacting of these, the dummy was ejected at 311 mph (500 km/h) while the 32 Beta was flying inverted at only 1,300 ft (400 m). For analysis of the seat's performance, cameras were installed at the Lansen's wingtips and on top of the front windscreen. As a reference, the number of each of the early tests was marked on 32502's fin and (prefixed by '37-') on the centre fuselage, making it appear that the machine wore a multitude of identity codes.

The modified Mk 2 seat was introduced to service in 1974 after 21 'Beta Lansen' test-flights, and continued in production until 1980, when 200 of the first- and second-generation seats had been built. During October-November 1980, the 'zero-zero' Mk 3 seat was tested on the rocket sled at Holloman AFB, New Mexico, at speeds up to Mach 1.13. Installation began with the 71st JA 37 interceptor, 37371, the earlier Viggens then being retrofitted.

Advanced avionics

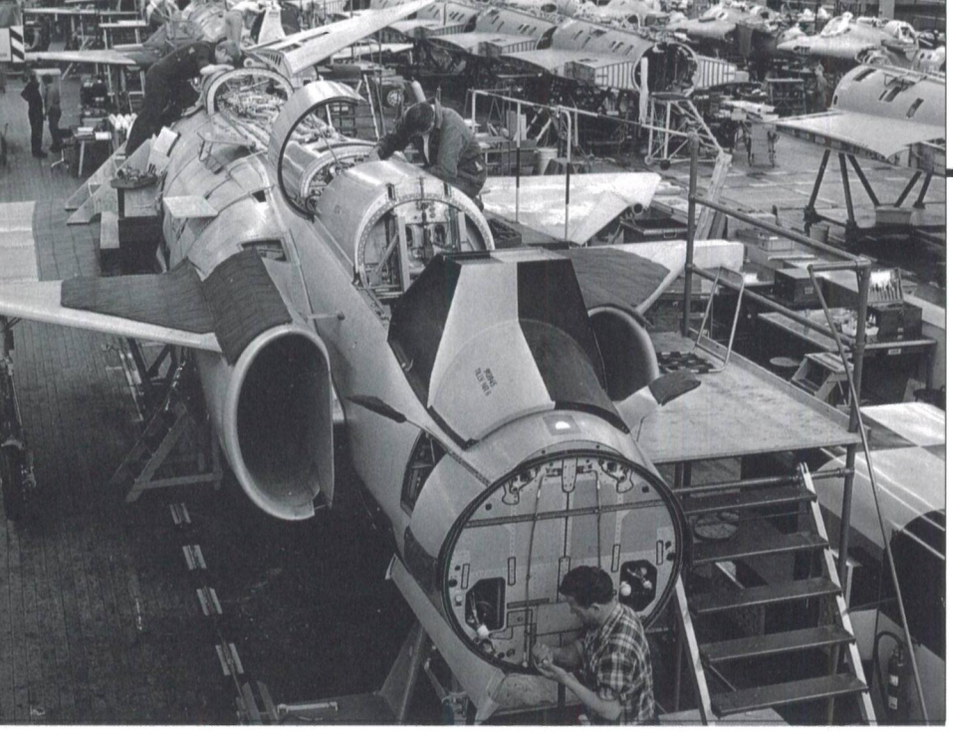
In selecting a single-seat aircraft to replace the two-seat Lansen for attack duties, the Fv committed itself to providing the pilot with a high level of systems automation to prevent mental overloading. No fewer than 50 avionics packages, with a total weight of 1,323 lb (600 kg), are included in the AJ 37, including L. M. Ericsson radar, Honeywell radar altimeter, Decca Doppler 72 navigation equipment, SATT radar warning receiver/ECM and a Saab CK 37 central computer. The last-mentioned performs 48 specific tasks in the aircraft and is capable of 200,000 calculations per second – pedestrian by today's standards, yet at the frontiers of tech-



Above: The second prototype is seen in flight with a load of two Rb04E air-to-surface missiles underwing. The original outboard wing leading edge shape is clearly apparent.

Left: An early AJ 37 is armed with air-to-air missiles.

Below: The first prototype Sk 37, seen before being fitted with an increased area tailfin.



Saab AJ 37 Viggens on the production line, with Drakens destined for Denmark taking shape behind.

Right: The first four AJ 37s delivered to the Flygvapen were initially used by the Försökcentralen for trials and instructor training.

An AJ 37 of F7 seen on approach. The aircraft wears the badge of JBG33, then a Luftwaffe F-104 wing, on its tailfin, presumably after an exchange visit.

nology when the Viggen was conceived.

For mission-planning, the CK 37 can be programmed with target position and intended intermediate way-points, specified time of attack, land-back base and alternates, plus the type and delivery method of weapons to be carried. The pilot will then be given a start-up time, take-off time, navigation prompts in the HUD and appropriate weapon-aiming symbology for the attack, followed by equivalent information for the return and landing. Radar allows the AJ 37 to attack at night or in poor weather, with weapons released automatically by the computer, if required. On entry into service, the CK 37 was expected to require overhaul every 25 hours, although this interval could be safely increased to 37.5.

Built-in test equipment (BITE) constantly monitors all essential equipment during flight and alerts the pilot to any failure of safety-related aspects. Viggens at alert on the ground – perhaps on a dispersal airfield miles from their home base – have the facility to monitor all their systems when the engine is running or with the assistance of a ground power line when it is not. If a malfunction is found, the Viggen will be hooked up to a pair of diagnostic trucks (TTBO-37 and KRAGG-37) which are able to run through up to 2,000 separate tests at the rate of one or two seconds each. Line-replaceable items and the previously-mentioned multiple access panels permit swift rectification when the fault is traced.

This modular approach holds true even for the radar, the 3,000 components of which are sub-divided into 13 replaceable elements, each of between three and eight assemblies. Designers and builders of the Lansen and Draken radars, Ericsson launched development of the attack Viggen's PS-37/A in 1958 and had progressed to ground-testing by 1961. PS-37 is almost totally solid-state and claimed to have good ECM resistance, thanks to lobe shaping which reduces side lobes. The Viggen's roomy fuselage allows the hydraulically-driven parabolic antenna to be of comparatively large diameter (about 32 in/80 cm), thereby improving range and target discrimination. The PS-37 operates in I/J-band for

optimum air-to-ground performance, but includes air-to-air modes.

Two Lansens were used to flight-test the Viggen's electronics, of which the '32 Alfa' (Alpha) first flew on 10 February 1965 as a conversion of A 32A 32080 '50'. Assigned to general avionics work, it was joined in the air on 14 December 1965 by the '32 Gamma', formerly A 32A 32280 '45' and easily identified by its extended, pointed nose containing the first airborne example of PS 37/A. Both aircraft carried additional avionics in the centreline fuel tank and pods under the port wing, the pair contributing 130 and 100 sorties, respectively, to the Viggen programme.

Powerplant

Choice of powerplant for the Viggen was interesting, to say the least. Pratt & Whitney's JT8D has been produced in many versions for installation in diverse makes of aircraft, but types such as the Boeing 727, McDonnell Douglas DC-9, Sud Caravelle 10/12 and Kawasaki C-1 have one thing

Top: Three Viggens en route to Farnborough for their international debut at the 1974 SBAC show. Two AJ 37s are accompanied by an Sk 37 trainer.

Above: Operation from roads and other off-base sites is an integral part of the Viggen's job. An AJ 37 is seen being re-armed and refuelled at a typical roadside base.

Left: Sweden is fanatically proud of the Viggen, and soon after the aircraft entered service the Flygvapen formed a two-aircraft display team, which is seen getting airborne.

Opposite: AJ 37s of F6 on the break. Each aircraft carries a pair of Rb 05A missiles under the engine intakes, with a fuel tank on the centreline. Two aircraft also carry chaff/flare dispensers and ECM pods.

in common: they are subsonic transports. For its Swedish application, the JT8D would need an afterburner and would be subjected to a very different lifestyle. This, coupled with the fact that the JT8D was a new engine, would introduce some risk into the programme, although the P&W name and the powerplant's widespread acceptance by other aircraft makers would be compensating factors.

First run in April 1961 (or a mere eight months before it was selected for the Fpl 37), the JT8D entered commercial service in 1963 with a thrust of 14,000 lb (6350 kg). Constructed of steel and titanium, the JT8D-22 version offered to Sweden has a two-stage front fan and four-stage, axial-flow low-pressure compressor, coupled with a seven-stage HP unit, for an overall bypass ratio of 1.1:1. At Trollhättan, Svenska Flygmotor AB (re-named Volvo Flygmotor AB in 1970) received three US-built engines in the winter of 1963-64 and bench-tested the first on 6 August 1964. At that time, design of a Swedish afterburner was still under way and that was not tested until the spring of 1965. Designed by Flygmotor, it increased the 14,735 lb (65.57 kN) dry thrust to 25,970 lb st (115.57 kN) and gave the complete installation – now 20 ft 2.2 in (6.15 m) long – its local designation of Reaktionmotor 8A (RM8A). Close examination would reveal that the JT8D-22 and RM8A differed in details such as different materials for certain components and changed dimensions.

The first of six trials engines was completed in September 1965, and in July 1968 a Kr689 million order was placed for 195 RM8As to power the first generation of 175 (later 180) Viggens for which the government had confirmed a requirement on 5 April that year. Deliveries of these began on 28 September 1970 for incorporation on the production line. On entry to service, time between overhaul of the RM8A was arbitrarily fixed at 250 hours with the intention of increasing to 600 hours as operating experience increased.

Three slots arranged annularly approximately 5 ft (1.5 m) from the extreme rear of the Viggen's fuselage are an external feature of the reverse-thrust system used for short-field landings. When primed and activated by pressure on the nose-wheel leg as the aircraft touches down, three lids completely close the jet exhaust and force air forwards through the slots to produce a braking effect. In normal flight, the slots remain open to feed air into the final stage of the jet pipe and reduce drag, but if the fully-variable afterburner is in use the slots are closed. This is an infrequent occurrence, as seven minutes at full throttle will use all the Viggen's internal fuel. The value of this in gallons or litres has not been disclosed, but it is known that fuel is contained in one tank in each wing, a saddle-tank over the engine and one behind the cockpit of single-seat versions. There is provision for a drop tank on the centreline, but inflight refuelling is not part of Swedish defence strategy, so no provision is made for a probe.

Prototypes

AJ 37 Viggen mock-up '37-0' was revealed to the press on 4 April 1965, at which time it was intended to be followed by seven flying prototypes. First of these, 37-1 was rolled-out at Linköping on 24 November 1966, began engine runs on 16 January 1967 and taxiing trials on 31 January. Erik Dahlstrom, Saab's chief test pilot, was aboard for the 43-minute first flight on the morning of 8 February 1967, although it was not until 6 April that the media was allowed to see the Viggen in the air. In natural metal, with national insignia on the nose and 'SAAB37-1' in black on the fin, the aircraft's only other decoration was the depiction of a thunderbolt on the air intakes in reference to the machine's popular name. Scholars of Norse mythology more accurately describe the viggen as a thunderclap made by the hammer of Thor, yet 'thunderbolt' is the normally accepted English equivalent.

Dahlstrom pronounced the aircraft to be as simple to fly as a sportsplane. However, the high nose-up attitude adopted

Above: Sweden remains the only operator of the Viggen, despite serious sales efforts in the late 1960s and early 1970s aimed at Japan, Britain, Belgium, Denmark, the Netherlands, Norway, and even Australia.

By comparison with the earlier Draken, the Viggen marked a massive improvement in capability and proved to have more docile handling characteristics.

29
17
34
20
6
FARA

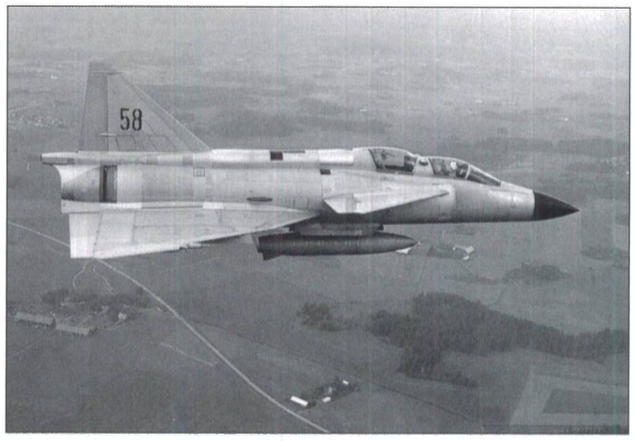
Right: Viggens quickly adopted a unique splinter camouflage pattern, consisting of angular patches of brown and three shades of green. The air force soon found that it could paint its aircraft more cheaply than Saab, and most aircraft were delivered in natural metal.

for short landings caught out even this experienced Draken pilot on one occasion, resulting in a scraped jet-pipe and the later installation of an audio warning device. A more tragic incident followed at Saab's airfield on 31 May 1968 when Lennart Fyrö accidentally ejected himself while on the early stages of take-off when he activated the seat while reaching for a dropped checklist. He was fired 230 ft (70 m) into the air, but the aircraft had not reached the seat's ground-level safe speed of 43 mph (70 km/h) and Fyrö was killed when the parachute failed to open fully. The pilotless 37-1 trundled across the airfield before hitting a drainage ditch and a hangar.

By October 1971, 37-1 was back in the air conducting spinning tests with its radar-less, probe-equipped nose painted black (top half) and red and with the port side of the fin coloured black and covered with wool tufts for airflow pattern measurements. This series of trials (also including a dummy SF 37 nose) extended until 10 April 1975, by which time 37-1 had made 183 spins during 93 sorties. The aircraft's final trials were conducted by the FMV at Malmslätt from 1 April 1979 and involved assessment of battle damage repair suitability. On 27 June 1979, Captain Arne Lindholm of the FMV flew 37-1 for the 1,133rd and last time – representing some 800 hours – following which it was placed in the Flygvapen museum at Malmslätt.

Jon Ertzgaard took 32-2 aloft for its first 65-minute flight on 21 September 1967. The aircraft's 'solid' nose was later exchanged for a more representative radome and it became one of five assigned to proving systems for the JA 37, as recounted later. Both 37-2 and 37-3, which flew on 29 March 1968, were used for weapons carrying tests, -3 being the first aircraft fitted with radar and the complete avionics suite. To improve longitudinal stability when carrying external stores, the 'solid'-nosed 37-4 (first flown 28 May 1968) had a sawtooth in the wing leading edge at two-thirds of span, resulting in repositioning of the radar warning receiver 'bullet'

Below: A Viggen pilot straps into his aircraft. The arming lever projects uncomfortably from the headrest. When it's stowed, the seat is armed. Often described as a zero-zero seat, at least 75 km/h forward speed is required for a successful ejection at ground level.



from a small pylon below the wing to the leading edge itself. This was retrofitted to earlier aircraft, but -4's career as an engine and weapons testbed was curtailed when it was lost on 7 May 1969. An eighth prototype (37-7) was ordered as a replacement.

Military trials at Försökcentralen were undertaken by the radar-equipped 37-5 (first flown 15 April 1969), which wore the unit's code 'FC' on the engine air intakes and '05' on the fin. Like its predecessors, 37-5 routinely carried camera pods to record weapon separation, sometimes including a forward-facing camera when engaged in rocket firing. With internal space limited, additional test avionics were installed in pods (marked 'MUNK' for Mätutrustningskapsel) to be carried on weapon pylons. Last of the envisaged single-seat prototypes, 36-6 flew on 24 January 1969 and embarked on a career of systems and weapons trials. It did, however, take time off to make the Viggen's international debut at the 1969 Paris air show, carrying the display number '752'. Also in large characters on the fin was '56', from the military callsign series 51-56 assigned as alternative identities to 37-1 to -6.

The seventh prototype was to have been the first two-seat Viggen, but this was put on 'hold' while a replacement for the crashed 37-4 was rushed through the works. Accordingly, 37-7 '57' flew on 20 November 1969, wearing a 'solid' nose, and resumed engine trials work and the occasional weapons proving. A further feature, introduced after the first flight, was a humped spine immediately ahead of the fin. First tested on 37-1, this was found to improve lateral stability at transonic speed and was made standard on production Viggens. Finally, wearing the military serial 37800 (callsign 58), the Sk 37 trainer made its delayed maiden flight on 2 July 1970 with Per Pellebergs in the front seat. At this stage it did not have the fin-tip extension soon added to the Sk 37 to improve lateral stability. However, sorties were routinely flown with a central drop tank to compensate for the sacrifice of an internal fuel tank. 37800 joined Försökcentralen as 'FC/22', from where it was briefly loaned to F7 wing for initial conversion of pilots. In chief, however, its career was in flight testing both for the Viggen programme and pure research.

The Viggen trainer is designated Sk 37 (for Skol, or school). This was the fourth production two-seater, and is seen after allocation to F7.

Far left: The first two-seater was the eighth Viggen built, later joining F7 and finally the Försökcentralen as a test aircraft.

Viggen variants

Four versions of Viggen comprised first-generation production by Saab: AJ 37, SF 37, SH 37 and Sk 37. Principal among these, the AJ signified Attack-Jakt, implying a primary attack role with interception as a secondary capability. The Fv remains coy to this day on the subject of AJ/SF/SH 37 combat weights, estimates being that the average empty mass is in the region of 26,000 lb (11800 kg). Normal take-off weight is about 35,300 lb (16000 kg), with the possibility of increasing to 45,100 lb (20450 kg) as maximum combat weight. This would include about 15,400 lb (7000 kg) of weapons, which are carried on seven hardpoints: three beneath the fuselage and two under each wing, all with standard 30-in (75-cm) store ejection racks. There is provision for activating a third hardpoint under each wing.

Primary weapons for AJ 37 are the indigenous Rb 04 and Rb 05 missiles, soon to be supplemented by the new Rb 15. Robot (Rb) is the Swedish term for guided missile. Con-

Left: A pair of early two-seaters blasts off. With the back seat replacing a large proportion of the Viggen's usual fuel load, the Sk 37 almost inevitably carries a centreline fuel tank.

Right: The first prototype SF 37, the dedicated photographic reconnaissance version of the Viggen. SF in this instance stands for Spaning Foto (Reconnaissance Photo). The first prototype made its maiden flight on 21 May 1973.

Below: An SF 37 of F13 seen at low level over the Baltic. The nose contains seven cameras, and there is no room for a radar. The cameras in the nose are augmented by recce pods carried on the shoulder pylons.

ceived in 1949 and weighing 1,358 lb (616 kg) in its present Rb 04E form, the first-mentioned was only the world's second active-radar ASM when it entered service on Lansens in 1958. Optimised for anti-ship attack, the Rb 04E has a range of up to 20 miles (32 km) in high-altitude launch mode and can be used in all weathers because of its on-board radar. Originally known as the Saab 305, Rb 05A is a smaller (672 lb/305 kg) complement for surface attack and is supersonic over a range of up to 5.5 miles (9 km). When launched, Rb 05 positions itself ahead of the aircraft, from where the pilot guides it to the target with a side-stick controller. RBS 15F is an air-breathing missile which uses a miniature turbojet to give it a range of over 90 miles (150 km). An effective replacement for Rb 04E, it weighs 1,318 lb (598 kg) and also has an active radar seeker for fire-and-forget performance in all weathers. When development was cancelled early in 1976 of the TV-guided Rb 05B, Sweden obtained the similarly-directed Hughes AGM-65A Maverick, which it called Rb 75, as a smaller (463 lb/210 kg) precision weapon with a 10-mile (16-

km) reach from sea-level launch. Maximum combat load for the Viggen is two Rb 04/05/15 missiles or four Mavericks.

Weapon options

Typical bomb load for an AJ 37 would be 16 M63FFV 265-lb (120-kg) fragmentation bombs and a centreline fuel tank, although heavier alternatives such as the 550-lb (250-kg) M50SB, 1,100-lb (500-kg) M56MB and 1,325-lb (600-kg) M50MB high-explosive bombs can be fitted. Standard rocket pod is the 880-lb (400-kg) Bofors M70 containing six 135-mm rockets with general-purpose or armour-piercing heads and a typical range of 1.25 miles (2 km). Four pods may be carried on the inboard wing and fuselage shoulder pylons. The AJ 37 has no internal cannon, an external option being the 802-lb (364-kg) FFV-built pod containing a British ADEN 30-mm weapon and 150 rounds. These are always carried in pairs. For self-defence or the secondary interceptor task, AAM options are the Rb 24 Sidewinder (AIM-9B, later upgraded to AIM-9J and then to AIM-9L) all of which are infra-red guided. Additional protection is provided by a 775-lb (350-kg) Ericsson Erijammer 200 H/I/J-Band electronic jamming pod which is effective against pulse and continuous-wave radars, and a 717-lb (325-kg) Philips (Bofors) BOX-9 chaff/flare dispenser (the latter also used by the Panavia Tornado IDS under the designation BOZ-100).

Two reconnaissance versions of Viggen approach their tasks in different ways, the most obvious difference being that one has radar and the other has a camera nose. Initial mention of such aircraft came early in 1971 when the government assigned Kr61 million to R&D for an S 37, the initial letter indicating Spaning (reconnaissance). First to appear, and equipped with the traditional type of camera-nose, was the SF 37 (Spaning Foto) replacement for S 35E Drakens (and some S 32C Lansens) for over-land operations. Following early feasibility studies with trials Viggen 37-7, the definitive prototype SF 37, 37950, first flew on 21 May 1973.

Seven cameras and a data recording unit are crammed into the SF 37's nose to bestow permanent low- or high-level capability. In the former category, a fan of three SKA 24Cs with 120-mm lenses (Cameras No. 1, 2 and 3) are fixed farthest forward, one pointing directly ahead and slightly downwards, complemented by a vertical VKA 702 infra-red camera and a No. 4 SKA-24. For long-range photography, two SKA 31s (Cameras No. 5 and 6) with 600-mm lenses are closest to the nose bulkhead, with another SKA 24 (Camera No. 4) – this time with a 57-mm lens – immediately ahead of the line scanner. The SKA 31s take either high-altitude vertical or medium-altitude oblique photographs, with the 57-mm camera providing reference pictures. In the centre of the pilot's in-strument panel is a periscopic sight viewing

Above: Arctic trials of the unpainted first prototype SF 37. The recce Viggens have a secondary ground attack and air defence capability.

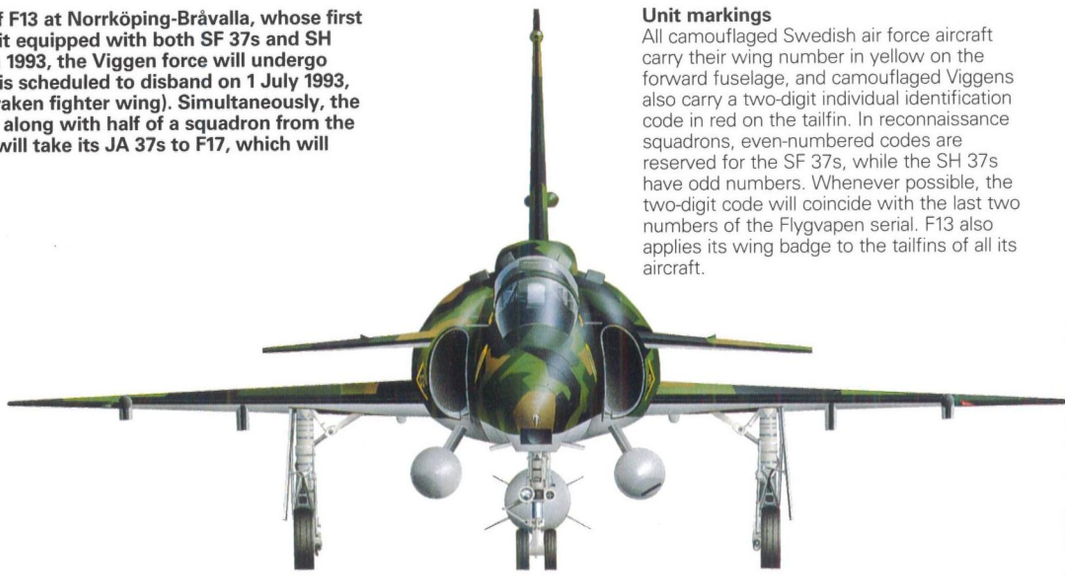
Above left: The two-seat Viggen has separate canopies for its tandem cockpits. The instructor has two periscopes, one on each side, to give a better view forward.

Far left (facing page): The shoulder pylons of the SF 37 carry one or two night reconnaissance pods, containing three SKA 34 cameras and two flash windows, each one filtered to limit flash coverage to the area being photographed. A capacitor pod can be carried to starboard, if required.

Below: Two-seat Viggens have increased fin area, with an increased-height, slightly swept, fin tip.

Saab SF 37 Viggen

This SF 37 (Spanings Foto) Viggen wears the markings of F13 at Norrköping-Bråvalla, whose first squadron (1 Spaningsflygdivision) is a reconnaissance unit equipped with both SF 37s and SH 37s. The unit's second squadron flies the JA 37 fighter. In 1993, the Viggen force will undergo major changes, with the disbandment of two wings. F13 is scheduled to disband on 1 July 1993, with 1 Spaningsflygdivision moving to F10 (currently a Draken fighter wing). Simultaneously, the reconnaissance squadron from F17 will also move to F10, along with half of a squadron from the disbanding F6 at Karlsborg. The second squadron of F13 will take its JA 37s to F17, which will become fully Jaktviggen equipped.



Unit markings
All camouflaged Swedish air force aircraft carry their wing number in yellow on the forward fuselage, and camouflaged Viggens also carry a two-digit individual identification code in red on the tailfin. In reconnaissance squadrons, even-numbered codes are reserved for the SF 37s, while the SH 37s have odd numbers. Whenever possible, the two-digit code will coincide with the last two numbers of the Flygvapen serial. F13 also applies its wing badge to the tailfins of all its aircraft.

Wing
The wing incorporates hydraulically-actuated two-section elevons on the trailing edge. The leading edge has compound sweep and is extended forward on the outer sections, outboard of prominent bullet fairings which accommodate an RWR antenna.

Nose gear
The nose undercarriage unit incorporates twin side-by-side nosewheels which retract forward. The aircraft is fitted with Dunlop anti-skid brakes, and the wheels are fitted with Goodyear tyres, inflated to 215 psi (mainwheels) and 155 psi (nosewheels).

Camouflage
Virtually all attack, trainer and reconnaissance Viggens, and many JA 37 fighters, wear a unique four-tone camouflage scheme. Consisting of three shades of green and one of brown (with undersides painted light grey overall) the scheme is known as the 'Fields and Meadows' camouflage, and is primarily designed to make the aircraft inconspicuous on the ground, when operating from dispersed sites. The upper surface colours are applied in hard-edged irregular slabs, whose disruptive nature tends to 'break up' the overall shape of the aircraft.

Windscreen
The Viggen's wraparound single-piece windscreen gives the pilot an excellent view forward, and is strengthened to withstand high-speed birdstrikes.

Folding tailfin
The fin can be folded down to port, reducing aircraft height and facilitating storage in Sweden's network of underground hangars. The powered rudder is of metal-bonded honeycomb construction.

Main undercarriage
The thinness of the wing dictated the use of tandem mainwheels, the incidental advantages of which include better energy absorption on landing and lower resistance to snow when taxiing. The mainwheel oleos are shortened during retraction. Made by Motala Verkstad, the undercarriage can withstand sink rates of up to 5 m (16 ft) per second, allowing steep approaches and no-flare landings.

Camera nose
The SF 37 dispenses with radar altogether, and instead has a battery of vertical and oblique cameras in its recontoured nose.

Left: From the pilot's point of view, perhaps the biggest change between the JA 37 and previous Viggen variants lies in the cockpit, seen here, which is dominated by two large square displays, one serving the new PS-46/A pulse-Doppler radar and the smaller right-hand display giving a readout of the tactical situation. Below this is the systems management panel. The weapons panel lies beside the radar display and shows the status of each weapons pylon, including details of what is being carried. Kneepads allow the Viggen pilot to have information readily to hand, or eye.

Saab SH 37 Viggen

1 Pitot head
2 Glass-fibre radome
3 Radar scanner housing
4 LM Ericsson PS-37/A radar equipment module
5 Incidence probe
6 Cockpit pressure bulkhead
7 Forward avionics equipment bay
8 Rudder pedals
9 Instrument panel shroud
10 One-piece frameless windscreen panel
11 Pilot's head-up display
12 Upward-hinging cockpit canopy
13 Ejection seat arming lev
14 Saab rucket-powered ejection seat
15 Engine throttle lever
16 Boundary layer splitter plate
17 Port air intake
18 Landing/taxiing lamp
19 Twin nosewheels, forwa retracting
20 Hydraulic steering contr

Inside the SH 37

Despite its unorthodox external appearance, the Viggen is a largely conventional 1960s fighter under the skin, using a mix of proven technology and some state-of-the-art approaches, but with few real innovations. This eminently sensible approach resulted in an aircraft with superb maintainability and reliability. The Viggen, though a large aircraft, is densely packed, and is therefore provided with a generous number of access panels.

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15 Engine throttle lever
16 Boundary layer splitter plate
17 Port air intake
18 Landing/taxiing lamp
19 Twin nosewheels, forward retracting
20 Hydraulic steering control
21 Red Baron multi-sensor reconnaissance pod
22 Centreline external fuel tank
23 Electro-luminescent formation lighting strip
24 Central avionics equipment bay
25 Intake ducting
26 Boundary layer spill duct
27 Forward fuselage integral fuel tank
28 Dorsal avionics equipment bay
29 Starboard canard foreplane
30 Canard flap
31 SATT AQ31 ECM jamming pod
32 SSR transponder aerial
33 Anti-collision light
34 Air conditioning equipment bay
35 Heat exchanger air exhaust
36 Intake flank fuel tankage
37 Engine compressor face
38 Accessory equipment gearbox
39 Foreplane spar attachment joint
40 Fuselage flank avionics equipment bays, port and starboard
41 Emergency ram air turbine
42 Port canard foreplane flap honeycomb panel
43 Hydraulic reservoirs
44 Formation lighting strip
45 Centre fuselage integral fuel tankage
46 Main engine mounting
47 Volvo Flygmotor RM8A afterburning turbofan engine
48 Engine bleed air pre-cooler
49 Fuel-cooled engine oil cooler
50 Wing spar attachment fuselage main frame
51 Fuel system recuperators
52 ADF aerial
53 Starboard wing panel
54 Outboard missile pylon
55 ECM antenna fairing
56 Extended-chord outboard leading edge
57 Starboard navigation light
58 Starboard elevon panels
59 Artificial feel system pressure head
60 Fin-tip aerial fairing
61 Multi-spar fin construction
62 Rudder hydraulic actuator
63 Fin spar attachment joints
64 Hydraulic hand pump for hangaring fin folding
65 Port lateral airbrake
66 Airbrake hydraulic jack
67 Afterburner ducting
68 Variable area afterburner nozzle control jack
69 Exhaust duct ejector seal (closed at speeds above Mach 1)
70 Ejector seal screw jack
71 Thrust reverser door pneumatic actuator
72 Radar warning antennas
73 Engine/afterburner exhaust nozzle
74 Thrust reverser blocker doors
75 Tail navigation light
76 Lower thrust reverser door pneumatic actuator
77 Port inboard elevon
78 Elevon hydraulic actuators
79 Elevon honeycomb construction
80 Port outboard elevon
81 Port navigation lights
82 Outboard elevon hydraulic actuator
83 Saab-Bofors Rb 24 (licence-built Sidewinder) air-to-air self-defence missile
84 Missile launch rail
85 ECM antenna fairing
86 Philips BOX9 chaff/flare launcher pod
87 Wing stores pylon
88 Honeycomb wing skin panels
89 Multi-spar wing panel construction
90 Wing panel integral fuel tank
91 Main spar
92 Main undercarriage wheel bay
93 Side breaker strut
94 Hydraulic retraction jack
95 Main undercarriage mounting rib
96 Mainwheel leg strut
97 Torque scissor links
98 Tandem mainwheels
99 Starboard fuselage pylon
100 Long-range camera pod
101 Rb 05A air-to-surface missile
102 Rb 04E air-to-surface anti-ship missile
103 Missile launch adaptor

Radar
The AJ 37 is fitted with an I-band monopulse Ericsson PS-37/A multimode radar, which gives ground-mapping, air-to-ground ranging, terrain proximity warning and limited air-to-air capability. A retrofit is believed to have added automatic terrain-following capability. Designed and flown (in a Lansen testbed) before the Viggen prototype took to the air, the radar consists of 13 line-replaceable modules for ease of servicing. Reportedly extremely reliable, the PS-37/A is also claimed to be extremely ECM resistant and to have excellent definition, with small side lobes and a very high grain main lobe. The radar was improved (chiefly with greater computer power) for the SH 37 and this improved version will be used in the new AJS 37 conversions.

Intake
The oval-shaped lateral intakes stand well away from the fuselage, to avoid the ingestion of sluggish boundary layer air, and are of plain, fixed type, since high supersonic speeds, where a more complex variable intake would be required, are of secondary importance

Canard foreplane
The Viggen's canard foreplane is a fixed surface, without dihedral, the purpose of which is to generate lift (especially on take-off) and is not a moveable control surface in its own right. It is, however, fitted with a moving trailing-edge flap.

Anti-ship missile
The Rb 04 and Rb 05 missiles which once formed the backbone of the Viggen's air-to-ground precision attack capability are now obsolescent, and used mainly for training. The main long-range missile now in use is the RB 15F, originally designed as a shipborne weapon, and using the basic airframe as the Rb 04, albeit with new cruciform tailfins replacing the old 'wings and endplates', and powered by a French Microturbo TRI-60-3 turbofan engine. This air-breathing powerplant gives a range in excess of 90 km (56 miles), while the combination of inertial and active radar guidance allows 'fire and forget' operation. The missile is usually fired from high level, and descends gradually for a final sea-skimming run-in to the target.

Armament options
For stand-off attacks, the AJ 37 can use a variety of air-to-ground missiles, including indigenous weapons like the RB 15F and the obsolescent Rb 04 and Rb 05, and foreign-designed weapons like the AGM-65 Maverick. Other weapons carried in the air-to-ground role include up to 16 M63 FFV 120-kg (265-lb) bombs, or smaller numbers of 250-kg, 500-kg or even 600-kg (551-, 1102- or 1323-lb) bombs can also be used. A favourite weapons option against soft targets is the Bofors M70 rocket pod, containing six 135-mm rocket projectiles. Up to four of these can be carried, or alternatively, the Viggen can carry a pair of 30-mm cannon pods. The centreline hardpoint is seldom available for the carriage of weapons, since it is 'plumbed' for the carriage of the almost inevitable external fuel tank. While air-to-air missiles and a variety of indigenous ECM pods and chaff/flare dispensers can be carried under the wing, this takes up valuable weapons stations and the Viggen is constrained by its lack of stores pylons and hardpoints.

The AJS 37 upgrade
One hundred and fifteen AJ 37s, SH 37s and SF 37s will reportedly be upgraded to a common standard as multi-role fighter-bomber and reconaissance platforms. This would seem to infer that the SF 37s will be fitted with a completely new nose section, and will lose their conventional optical reconnaissance cameras. To arrive at the required figure of 115 AJS 37s, however, some SF 37s will have to be modified, since there are insufficient surviving AJ 37s and SH 37s, and some older AJ 37s are already slated for retirement. All the converted aircraft will reportedly receive a new computer-based threat analysis and mission planning system, and increased memory and data processing for the radar. Armament options will include the BK/DWS39 missile, giving a much-needed boost in precision attack capability. Multi-role capability will be conferred by use of the recce pod originally developed for the JAS 39 Gripen. The first AJS 37s are due to become operational in late 1993.

National insignia
The Kingdom of Sweden uses as its national insignia three stylised yellow crowns on a yellow-ringed blue roundel. This is carried in six positions, above and below each wing and on each side of the forward fuselage.

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Saab AJ 37 Vig
F6 Västgöta Fl
Flygvapen
Karlsborg, Sw

This well-armed AJ 37 wears the markings **disband Karlsborg-based F6, over its four-t** **Meadows' splinter camouflage pattern. Th** **squadrons are each equipped with the AJ** **the Saab 37, and the unit has no reconnais** **squadrons. F6 is due to disband on 31 Dece** **its squadrons will disband. Approximately** **of Sweden's oldest Viggens will then be re** **instructional duties, or find new careers as** **exhibits, decoys, or BDR training aircraft. S** **scrapped. Half a squadron's worth of AJ 37**

Attrition
The Viggen force has suffered relatively high attrition, some losses being directly attributable to its single-engined configuration. The extra cost, size, weight and complexity of a twin-engined aircraft are still felt to be unacceptable penalties, however, and Sweden's next-generation fighter, the Gripen, is also a single-engined machine. By 1992 20 AJ 37s, two Sk 37s, three SH 37s and four SF 37s had been lost in accidents, together with 10 JA 37s. Three early structural failures led to a fleet-wide grounding, and the cause was found to be inadequate quality control in the manufacture of a handful of aircraft, which had allowed loose articles to be left inside the structure, stuck in sealant.

Tailfin
A prominent fairing on the port side of the tailfin accommodates the hydraulic actuator for the honeycomb rudder, while the entire fin folds to port at its base to allow stowage in Sweden's underground hangars. On camouflaged Viggens, fin codes (which indicate the individual aircraft's identity within the wing) are always applied in red. The AJ 37 and the two reconnaissance Viggens retain the original short tailfin of the prototype Viggen, with a pressure head for the artificial feel system mounted near the top of the leading edge.

Saab AJ 37 Viggen
F6 Västgöta Flygflottilj
Flygvapen
Karlsborg, Sweden, 1992

This well-armed AJ 37 wears the markings of the soon-to-disband Karlsborg-based F6, over its four-tone 'Fields and Meadows' splinter camouflage pattern. The wing's two squadrons are each equipped with the AJ 37 attack version of the Saab 37, and the unit has no reconnaissance or fighter squadrons. F6 is due to disband on 31 December 1993, and both its squadrons will disband. Approximately one squadron's worth of Sweden's oldest Viggens will then be retired to ground instructional duties, or find new careers as gate guards, museum exhibits, decoys, or BDR training aircraft. Some may even be scrapped. Half a squadron's worth of AJ 37s will be transferred to F10 (currently a Draken operator, but soon to augment these with F17's recce Viggens), and the other half to F15, giving that wing two full AJ 37 squadrons in addition to its Sk 37 trainers. The AJ 37s transferred to the reconnaisance squadron at F10 will give that unit a useful attack capability, helping train the SF and SH 37 pilots for a wider range of duties. The days of the AJ 37 are far from over. It will be many years before the new JAS 39 Gripen is available to replace the Viggen, and to prepare them for the long interim the surviving attack and reconnaissance aircraft are to be modernised and upgraded to a common and more capable standard as AJS 37s.

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Conversion
Because the Sk 37 has severely restricted fuel capacity it is of limited use for operations or operational conversion training. To minimise cost, the aircraft also lacks radar (despite its radome), and this means that students destined for the AJ 37, SH 37 or JA 37 must learn how to use the radar and weapons system of their aircraft in the simulator, and during sorties in single-seat aircraft. The Sk 37 is thus used purely to teach student pilots how to fly the Viggen, and to get used to its handling characteristics with an experienced instructor sitting behind. Because of its limited usefulness, only 17 Sk 37s were procured, and most of these serve with F15, which effectively functions as the Viggen OCU.

Thrust reverser
Among contemporary fast-jet combat aircraft only the Saab Viggen and Panavia Tornado use a thrust reverser mechanism to shorten the landing run. While the Tornado uses huge mechanical external buckets which swing down behind the jet nozzles, directing the engine thrust forward, the RM8A's thrust reverser uses lids inside the rear fuselage, which open up to close off the jet pipe and force the thrust forward through an annular ring in the rear fuselage. Both systems deploy automatically, by detecting landing gear oleo compression. This annular ring remains open in subsonic flight, reducing drag by removing sluggish boundary layer air from the rear fuselage and providing cooling air for the afterburner.

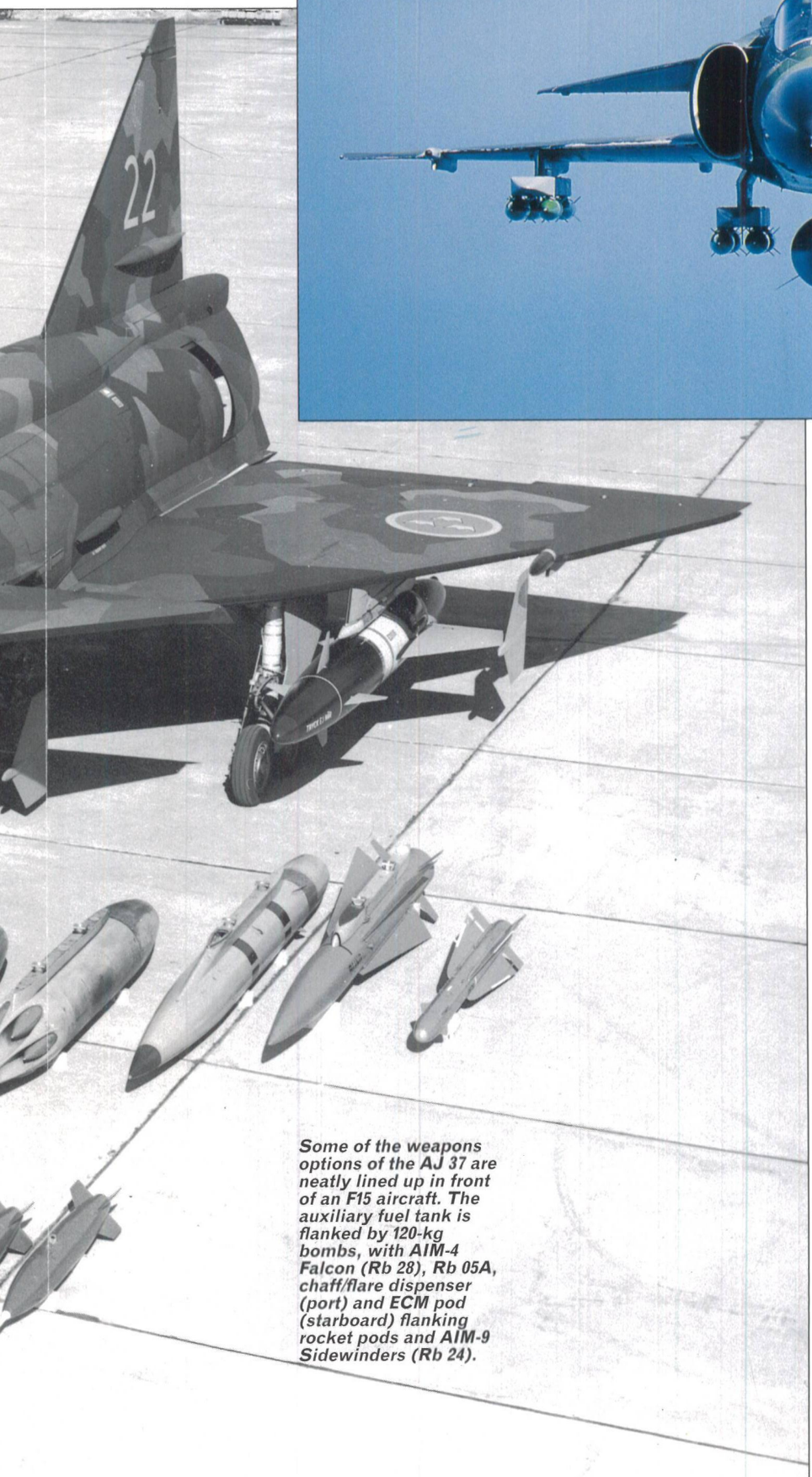
Powerplant
All Viggens, apart from the JA 37 and the stillborn export J 37E (or Saab 37X), are powered by the Volvo Flygmotor RM8A afterburning turbofan. This engine is basically a licence-built version of the Pratt & Whitney JT8D-1, a proven civil airliner powerplant mated to an indigenously designed afterburner and, in view of Sweden's demanding STOL requirements, a new thrust reverser as well.

Left and below left: The Saab 305 has the air force designation Rb 05 and is a short-range radio-command-guided air-to-surface missile, powered by an unusual liquid fuel rocket motor. Production ceased in 1977, and it is now mainly used for training.

Right: This AJ 37 carries 16 120-kg bombs, four to a pylon, alongside the inevitable centreline fuel tank.

Some of the weapons options of the AJ 37 are neatly lined up in front of an F15 aircraft. The auxiliary fuel tank is flanked by 120-kg bombs, with AIM-4 Falcon (Rb 28), Rb 05A, chaff/flare dispenser (port) and ECM pod (starboard) flanking rocket pods and AIM-9 Sidewinders (Rb 24).

Right: This AJ 37 carries 16 120-kg bombs, four to a pylon, alongside the inevitable centreline fuel tank.



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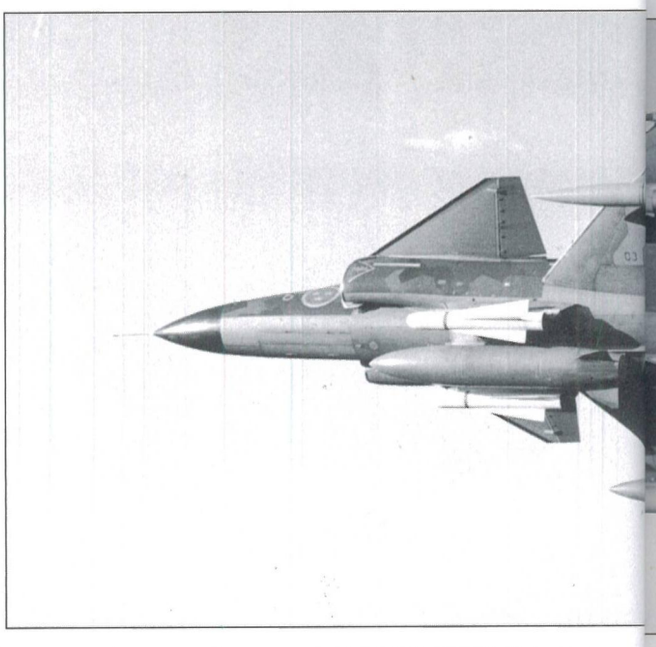
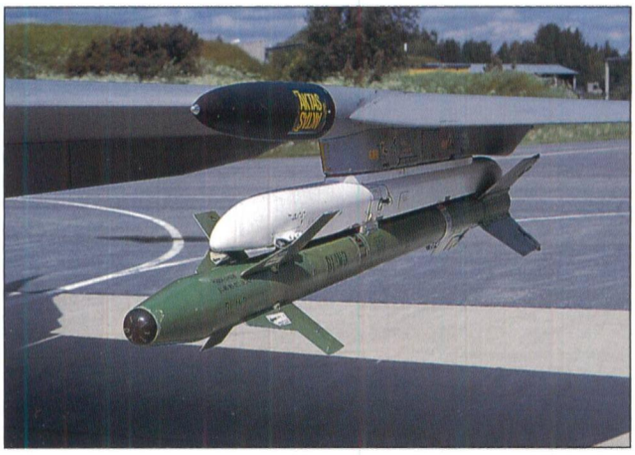


Above: The Viggen can carry indigenous 135-mm rockets in underfuselage and/or underwing pods, each containing six rocket projectiles. Other calibres of rocket may also be carried.

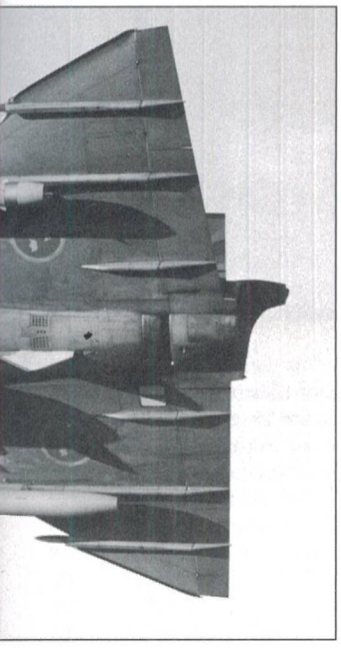
Right: The Rb 04 is a medium-range anti-ship missile, with inertial guidance and active radar terminal homing. Broad-span wings are tipped by huge vertical endplate fins.

Viggen Weapons



Above: Sweden designates its Sidewinders Rb 24 (AIM-9B and AIM-9J) or Rb 74 (AIM-9L). An Rb 24 is seen here.

Above: Standard BVR weapon for the JA 37 is the Rb 71 Sky Flash, which is due to be replaced by the Rb 71a Active Sky Flash, or perhaps by the ambitious Rb 73, a ramjet-powered hypersonic missile.



Above: Sweden builds the US AGM-65 Maverick under licence as the Rb 75. Two such missiles are being carried by this AJ 37. Maverick has effectively replaced the Rb 05.

Right: This JA 37 carries a typical mix of Rb 74 and Rb 71 missiles. Combat persistence is constrained by the ability to carry only two BVR missiles. Up to four Sidewinders can be carried for close-in engagements, augmented by 150 rounds of 30-mm ammunition for the cannon.

Right: Demonstrating that the JA 37 has a genuine secondary ground attack capability, this Viggen fighter of F13 carries rocket pods underwing, with Sidewinders outboard. Such a warload is far from routine, and was adopted for the Paris air show.

Above: This F13 SF 37 carries a full load of centreline fuel tank, night reconnaissance pods, and underwing chaff/flare dispenser and ECM pod (to starboard).

Three of Sweden's Viggen wings each have a reconnaissance squadron (Spaningsflyg-divisionen) operating a mix of SF and SH 37 Viggens.

Below: The SH 37 is a dedicated maritime reconnaissance platform, which retains radar and carries only podded cameras.

through an aperture in the lower starboard side of the nose for aligning vertical photography.

The formidable array of nose cameras is augmented by photo pods on the fuselage shoulder pylons. The port night reconnaissance pod (Mörkerspaningskapsel) contains three SKA 34 cameras with 75-mm lenses covering a total of 120° and, at the rear, two flash windows. To starboard, the Blixtkapsel contains capacitors which are charged from the aircraft's electrical generators to release power to the flashguns when required for illumination at heights up to approximately 1,640 ft (500 m). Operational equipment under the wing comprises chaff/flare (port inner) and jamming (starboard inner) pods as per AJ 37, plus a pair of Rb 24 Sidewinders (outboard).

Surveillance

Havsövervakning – coastal surveillance – provides the 'H' in SH 37, the radar-equipped Spanings Viggen. The third production AJ 37, 37003, was rebuilt as the prototype SH 37 37900 and returned to the air as such on 10 December 1973. Destined to replace S 32C Lansens in the over-water role, SH 37 has the greater-range Ericsson attack radar optimised for maritime operation under the new designation of PS-371/A and equipped with an RKA 40 recording camera for post-flight replay of radar imagery. There is also a data camera for recording position, course, altitude and target location and a tape-recorder for the pilot's commentary. The CK 37 central computer has greater memory than that of the AJ 37 attack aircraft. Fuselage shoulder positions have provision for the SF 37's night photography pod to port and starboard and a single, forward-facing long-range optical fitment on the starboard shoulder pylon containing an SKA 24D camera with 600-mm lens. Chaff/flare, jammer and missile positions are the same as for the SF 37. Fv operating policy is for SF 37s and SH 37s to be based in the same squadrons for tactical flexibility. During the years of East-West confrontation, the SH 37s were particularly busy monitoring the sizeable naval forces operating in the Baltic – mostly Warsaw Pact, but occasionally also including NATO.

Conversion trainer

Unlike most two-seat versions of combat aircraft, the Sk 37 has distinctly separate canopies for its two occupants. In spite of this, however, the instructor in the rear seat is provided with a periscope on each side of the fairing between the two cockpits in order to monitor the landing approach. The Swedish word for school – Skol – gives the Sk 37 its designation, and it should be noted that the lessons given are of a basic nature. Despite its radome, the Sk 37 has no radar and, consequently, no radar navigation capability, having to rely on Doppler and the later addition of DME. Compared with the AJ 37 on which it is based, the Skolviggen has reduced fuel capacity and its internal avionics have been rearranged to accommodate the rear cockpit. Students' use of the AJ 37 or JA 37 weapons systems must therefore be practised in the appropriate simulator, followed by sorties in a single-seat aircraft. Sk 37s have a limited operational potential with bombs, rockets and cannon.

Early service performance of the AJ 37 proved promising, with a requirement for 22 maintenance hours per flying hour and direct operating costs of $500 per hour, of which $83 was for fuel. However, training of new squadrons, progressing satisfactorily, was abruptly stopped on 10 October 1975 when the entire Viggen fleet was grounded following three structural failures. The losses on 6 and 10 October, as well as an inflight break-up on 11 July 1974, were found by painstaking examination to result from main spar fatigue at either the port or starboard wing root. Flight-testing was allowed to resume early in January 1976 and squadrons returned to operations in mid-March, although with a 4*g* manoeuvring limit.

Only the first 27 AJ 37s had been built with spars susceptible to fracture, of which three had been lost to other causes,

leaving 21 machines in need of rectification. Costing Kr300,000 per aircraft, the repair programme involved discarding the existing 12-mm metal components and replacing them with 41-mm thickness. There were no further problems of such magnitude, yet Fv C-in-C, General Dick Stenberg, had to admit in mid-1979 that Viggen attrition had been higher than that of its Lansen and Draken predecessors and had taken longer to improve after the usual spate of early accidents affecting any new aircraft. Losses by that time totalled 21 from almost 180 machines and by 1992 had increased to at least 39, comprising 20 AJs, 10 JAs, two Sks, three SHs and four SFs. A particularly Swedish accident worth recollection occurred at Norrköping on 28 September 1982 when a Viggen of F13 wing attempting to take off was confronted by a herd of elk on the runway. The aircraft sustained slight damage and one elk was written off.

Jaktviggen

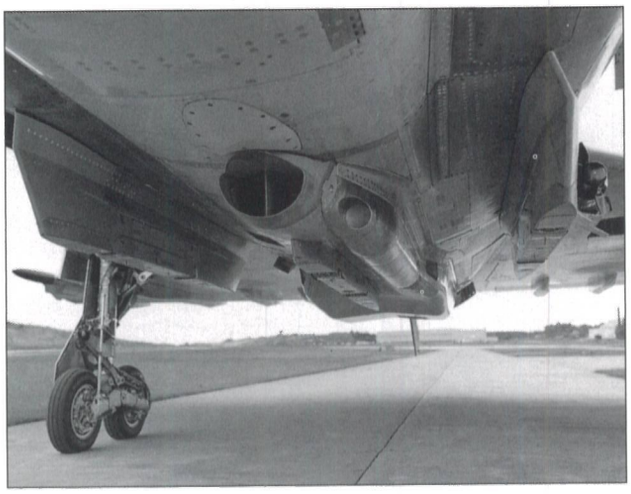
Compared with the minimal changes necessary to adapt the first-generation Viggen from attack to reconnaissance, conception of an interceptor required a more fundamental adaptation of the design, leaving it little changed externally, but a very different aircraft under the skin. The Jakt, or Fighter, Viggen was not required in the same timescale as its AJ, SF and SH compatriots, as the J 35 Draken was still effective in air defence, allowing more scope for development of new avionics, especially radar, optimised for air-to air operations. Design work for the JA version had been under way at low priority since 1968 and had been endorsed by the Air Force Board late in 1970, followed by the government 12 months later. Activity wound up to full speed in October 1972 when major equipment contracts were let by FMV to cover operations up to 1 February 1975: Kr230 million went

Above: An SF 37 manoeuvres hard at low level, showing off the Viggen's distinctive wing planform. The extended outboard leading edge was added to improve longitudinal stability with external stores.

Left: The SH 37 has greater radar range and a computer with greater memory and faster processing. SH stands for Spanings Havsövervakning (reconnaissance coastal surveillance).

Above: The new-build JA 37 prototype was augmented by five of the original AJ 37 prototypes, some of which received the new RM8B engine, and others the taller fin with swept tip.

The JA 37 version of the Viggen is fitted with a fixed gun, in the shape of an underfuselage Oerlikon KCA 30-mm cannon. This is carried in a fixed ventral gondola.



to Saab-Scania for development and production preparation; Kr160 million to Volvo Flygmotor to continue work on the projected RM8B engine; Kr9 million to Singer-Kearfott for an inertial navigation system (INS); Kr2 million to Garrett AiResearch for digital air data sensors; Kr70 million to L. M. Ericsson to develop a target acquisition system; and Kr28 million to Svenska Radio for the EP-12 electronic display equipment.

Fighter development

These sums were among the Kr775 million voted for JA 37 in the 1973-74 defence budget, which also envisaged reworking of four AJ 37 prototypes to assist the JA programme as well as assembly of a new-build machine as the definitive JA 37 prototype. In the event, five were modified to undertake some aspect of Jaktviggen development, the process accompanied by a subtle change to their test serial numbers, although the callsigns remained the same. Those were:

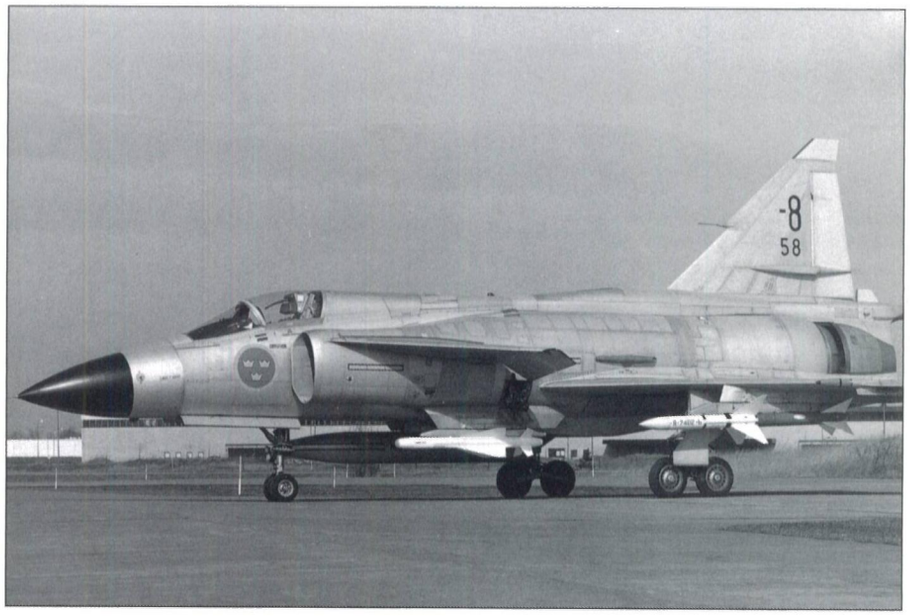
Right: 37-71 (previously the seventh AJ 37) was the second JA 37 testbed to fly, and the first with the RM8B engine and stretched fuselage. It retained its solid, radarless nose and short fin.

AJ 37 no.	Callsign	JA 37 test no.	'First' flight
37-2	52	37-21	4 June 1974
37-3	53	37-31	22 November 1974
37-5	55	37-51	10 May 1975
37-6	56	37-61	September 1976
37-7	57	37-71	27 September 1974

As previously noted, external differences between the first- and second-generation Viggens are minimal, and perhaps the most reliable identification feature in the days prior to light grey camouflage was the 12-in (30-cm) fin-tip extension (*à la* Sk 37) of the interceptor. More subtle, as a result of the RM8B engine being 2.75 in (7 cm) longer than the RM8A, was a 3.5-in (9-cm) fuselage stretch immediately ahead of the wing leading edge intersection. Consequently, the canard's trailing edge and wing leading edge were no longer directly in line where they intersected the fuselage, and the JA variant is, in all, 5.2 in (13 cm) longer than the AJ. Elsewhere on the airframe, the JA has a VHF blade aerial on the fuselage to the rear of the rudder and an extra elevon actuator beneath each wing.

Testing began with 37-21 fitted with the fighter's control system, with which it would conduct stability trials (aided by the taller fin) before adding pre-production RM8B engine testing to its responsibilities. 37-71, next to fly, in the hands of Per Pellebergs, was the first RM8B platform, with appropriate fuselage 'plug' and new VHF aerial, though still with its 'solid' nose and short fin. Its career was cut short by a compressor explosion on 27 August 1975. Electronics and Oerlikon cannon development was the role of 37-31, which later aspired to a pre-production radar, although it had the RM8A engine and short fin. Fourth to fly, tall-finned 37-51 took a part in the electronics programme before moving on to weapons work, including cannon, Sky Flash and Sidewinder. The new-built JA 37 prototype, 37-8 '58', equipped with pre-production avionics and an RM8B, took to the air on 15 December 1975 with Ulf Frieberg in command. As the most representative JA 37 it was dedicated to performance testing of the avionics in various mission profiles until an in-flight fuel fire resulted in loss of the flight control system and a crash near Atvidaberg on 22 August 1978. Finally, as a replacement for 37-71, 37-61 was fitted with an RM8B to act as the principal engine testbed.

In a later incarnation, 37-21 received the triplex fly-by-wire control system for the JAS 39 Gripen, with which it undertook 50 hours of flight-testing as the Viggen ESS (Elektriskt Styrsystem), beginning on 14 September 1982. 37-31 ended its days in Flygvapnets Tekniska Skola (The Air Force Technical School) as an instructional airframe, as did 37-61 with Kungliga Tekniska Högskolan (The Royal Technical High School) in Stockholm.



As the most representative Jaktviggen, the new-build prototype was used mainly for operational avionics testing and integration. The aircraft carries a Saab 372 (Rb 72) IR-homing AAM inboard. This promising indigenous missile was powered by solid-propellant rocket motors, but was cancelled in January 1978 for financial reasons, and was replaced by the AIM-9L (Rb 74).

New avionics

Radar being the prime sensor of an interceptor, it is appropriate first to examine the multi-mode, pulse-Doppler PS-46/A developed by L. M. Ericsson for the JA 37. Naturally optimised for the air-to-air role while conferring upon the Jaktviggen the ability to perform its secondary attack task via an air-to-ground ranging mode, the I/J-band PS-46/A demonstrated a reliable look-down detection range of 30 miles (50 km) against realistic targets during its 1,000-hour flight-test programme. Air defence modes available are target search, automatic target acquisition (through the HUD), semi-automatic target acquisition (through the HDD, or head-down display), target track-while-scan, continuous target tracking and continuous wave target illumination, all of which are claimed to be unaffected by altitude or weather. PS-46/A comprises 11 line-replaceable units (LRUs), one of which is the lightweight support frame. Typical replacement times in the aircraft are eight minutes for the data processor and 12 minutes for the transmitter, using only two sizes of socket wrench. A mean time between

Previously the fifth AJ 37 prototype, 37-51 tested JA 37 avionics before moving on to weapons development, with gun, Sidewinder and Sky Flash.

Above: The first real JA 37 was termed a pre-production machine, because it was retained by Saab at Linköping for development work. It is seen here with a test instrumentation pod on the starboard shoulder, and with two Sky Flash and four Sidewinder missiles.

The first pre-production JA 37 took over much of the development programme previously allocated to the prototype, which was lost after an engine fire on 22 August 1978.

failures of 180 hours has been proven in service.

Although the AJ 37's cockpit layout received wide acclaim, its interceptor successor further improves the pilot's environment and the ease with which he can assimilate data. Key items are the HUD, HDD and tactical display which, together with a waveform generator and power supply, constitute the Ericsson EP-12 system. HUD design is by Smiths Industries and includes a 28° field of view, symbology for low-level flight and an optical aiming mode for close combat. The latter works in conjunction with a single switch on the throttle which also brings onto line the radar search and lock-on, aiming and weapons selection so that the whole aircraft can be instantly configured for engaging a target of opportunity. HDD is used during radar search to provide the pilot with speed, altitude, attitude and terrain-warning information in order that attention need not be divided with other displays. Data is both analogue and digital, and comes from ground control and the aircraft's systems after target lock-on. Finally, the tactical display is a map presentation including data for interception, navigation and landing on which the pilot may insert way-points or other markers via the central computer.

The computer itself is a Singer-Kearfott SKC-2037 built under licence by Saab as the CD 107. With five times the capacity of the AJ 37's CK-37, it wisely uses this capability to *reduce* the data presented to the pilot to that specifically required for the task in hand. Other items simplifying the single occupant's task include the LD-5 digital air data computer adapted from technology used in the Grumman F-14 Tomcat; Singer-Kearfott's quick-aligning INS, offering accuracy of less than 1 nm (1.2 miles/1.85 km) drift per hour; and the Honeywell/Saab SA 07 flight control system. The latter is the first such digital system to enter production, and offers high combined load factor and roll rate command capability.

In nominating the AJ 37 airframe as the basis of a later interceptor, the FMV was holding the JA 37 hostage to an old design philosophy. By the time the fighter Viggen began to

Above: F13 was the first wing to receive the JA 37, these going to its second squadron three years after its first squadron had re-equipped with SF and SH 37s.

Left: The first JA 37 squadron was Martin blä of F13 at Norrköping, which converted from the Draken. Initially four JA 37s were complemented by Sk 37s borrowed from F15. The squadron had to transition back to Drakens temporarily, following the grounding of the JA 37 fleet between June and October 1981.

take shape, air forces were beginning to ask for a better all-round view from their interceptors and some were questioning the wisdom of having just one occupant. The Viggen's solid spine and canard presented obstacles to rear/downward vision (which have been slightly improved in the JAS 39 Gripen), while the short-legged and ungainly Sk 37 was no basis for a tandem-seat air defence machine, even if the two-crew argument had been accepted. Comparisons between the Viggen and its nearest European equivalent, the Tornado ADV, must not be overstressed, however. The ADV was designed to undertake long-range missions involving protracted loitering supported by tanker aircraft; JA 37 conforms to the Swedish defensive philosophy of short duration sorties at a brisk tempo. In any event, two crew require a larger, heavier aircraft – and in crude terms, a heavier machine is a more costly one. The Tornado is probably 20 per cent more expensive than a JA 37, a not unimportant consideration for a small nation.

Unknown quantity

Furthermore, the Viggen would appear to be a more agile fighter than the Tornado ADV, although by what margin is not clear. Keeping itself to itself, Sweden does not undertake regular squadron exchanges and never participates in any organised international war-games such as Red Flag, Maple Flag or even the ongoing air combat manoeuvring exercises over the Decimomannu or North Sea instrumented ranges. The main possibility for dissimilar air combat is with the ageing Draken. The learning curve against an F-16 Fighting Falcon or expertly flown 'aggressor' F-5 Tiger II would be far steeper, and it may be suggested that punctilious neutrality has prevented Sweden from making the most of its undoubtedly intelligent and highly-motivated pilots. On the NATO side, few fighter pilots will have seen a Viggen (even at an air show), let alone 'mixed it' with one.

Structurally, the first- and second-generation Viggens are similar, apart from reinforcement – mainly of the wing – to cope with higher load factors. After adding this to the heavier engine and radar, and the added cannon, the empty JA 37 tips the scales at about 26,900 lb (12200 kg), or 880 lb (400 kg) more than the AJ 37. Normal take-off weight is some 37,040 lb (16800 kg), and the maximum is 49,600 lb

Below: A fully armed JA 37 on patrol. Wing badges are rare on Swedish air force aircraft.

Opposite page, top: A JA 37 of F4 operating in natural metal finish. Several 'silver' JA 37s have been used by squadrons prior to being painted in camouflage by the air force.

Right: The same four-tone splinter camouflage worn by attack and reconnaissance Viggens was also applied to fighters.

In 1982, F13 began to experiment with dedicated air defence colour schemes. One aircraft was painted white overall, another pale blue, and a third grey.

(22500 kg). In 1984, a fin made of composites materials was flight-tested on pre-production JA 37 37301 and subsequently fitted to 19 late-production machines, beginning with 37412.

The fighter aircraft's requirement for manoeuvre demands a greater surge margin for its powerplant, compared with an attack machine. Consequently, in 1970 Volvo Flygmotor, in conjunction with Pratt & Whitney, launched development of the RM8B engine, offering 10 per cent additional thrust. Most significant of the changes introduced to improve functional reliability is to take the first stage off the low pressure compressor and add it to the fan, resulting in a three-stage fan and three-stage LP spool, both with a revised aerodynamic configuration deriving from research continued after the RM8A's design was frozen. Additionally, there is a new high-pressure turbine to cope with increased operating temperatures and a four-nozzle afterburner to increase thrust. Testing of the first HP compressor was undertaken by P&W's high-altitude laboratory at Willgoos during 1971.

By June 1973, five prototype RM8B engines had been built at Trollhättan and bench testing had reached 500 hours, from 4,500 hours required. The later engine is slightly longer and weighs 4,900 lb (2220 kg), against the RM8A's 4,630 lb (2100 kg). Thrust is raised to 16,200 lb (72.09 kN) dry and 28,110 lb (125.09 kN) with afterburning with only a small increase in fuel consumption. Smoke production is reduced as a result of each of the nine flame tubes having four duplex fuel spray nozzles (instead of the RM8A's single nozzle) for more efficient combustion. The last RM8B was delivered on 19 September 1988.

Guns and missiles

Interceptor weapons also differ from those of the attack and reconnaissance variants, most noticeably in the adoption of a fixed cannon. This is housed in a belly pod, which does not block the three underfuselage pylons, and has 150 rounds of 30-mm ammunition on the starboard side and the cannon itself to port of the centreline. The Oerlikon KCA weapon developed for the Viggen is claimed to be the first cannon with a range equivalent to a first-generation AAM. It has a muzzle velocity of 3,445 ft/sec (1050 m/sec), a fire rate of 1,350 rounds per minute and a slip-off of 4° at 550 yd (500 m). From the standpoint of an enemy aircraft, the KCA's projec-

tile weight (12.7 oz/360 g) is half that again of the British ADEN or French DEFA of similar calibre and arrives with eight times the kinetic energy.

New missile armament for the interception role comprises both the heat-seeking Sidewinder and semi-active radar homing BAe Sky Flash. As a follow-on to the AIM-9J (Rb 24J) version of 'Winder, Sweden had launched development of the Saab 372 during the mid-1970s, with the intention that this should re-equip JA 37s and be known as the Rb 72. The programme was abandoned in favour of buying-in the 'all-aspect' AIM-9L – initially designated Rb 24L but soon re-named Rb 74. US permission had to be sought to procure the weapon as the -9L's seeker technology was restricted to NATO and 'special cases'. Sales were approved in mid-1982, but the finance for purchase did not become available until mid-1984 when an initial 1,000 missiles were bought for Kr600 million. Sidewinder is normally mounted on the outer wing pylons and, optionally, the fuselage shoulders. At about the same time that AIM-9L was being received, JA 37s were equipped with a new communications system known as Fighter Link, which allowed digital inter-aircraft communications.

Sky Flash, fitted to the inboard wing pylons and locally named Rb 71, is a British adaptation of the AIM-7 Sparrow with, most significantly, a new seeker. BAe received an FMV contract to assist Saab-Scania and L. M. Ericsson with designing the interface between Rb 71 and the JA 37 airframe and radar, leading to the start of a three-year proving programme in 1978 in which live launches were undertaken against target drones by the fourth development AJ 37. The first Sky Flash order, valued at £60 million, was placed in December 1978, with deliveries to begin in mid-1980. It was followed by an £11 million second batch ordered in mid-1981, and a third in early 1982, increasing the total value of Rb 71 sales to £85 million. An active-seeker Sky Flash was considered for the JAS 39 Gripen as Rb 71A before being abandoned, and might have found an application on the Viggen during the late 1990s. The venture was restarted as Rb 73 with Saab and BAe collaborating, then overtaken by Rb 91, with which it is intended to equip JA 37s, if integration is feasible. The 'A' element of JA 37 indicates secondary attack capability with up to four pods of six 135-mm rockets each.

Left: This aircraft was painted light grey overall as part of the 1982 experiments to find a suitable air defence colour scheme. A two-tone grey scheme was eventually selected.

All three colour scheme testbeds are seen in flight with five of their more conventionally coloured companions.

Above: Sweden's Viggens are frequently scrambled to investigate uninvited guests who fly too close to Sweden's airspace. Here an F13 JA 37 shadows a Tu-16N 'Badger' tanker.

Below right: A JA 37 stands at readiness on a typical roadside dispersal during an off-airfield excercise.

The Viggen's four-tone 'Fields and Meadows' camouflage is remarkably effective for dispersed site operations, as shown by this F17 Viggen fighter.

JA 37 gives the Fv an effective interceptor with a time of under 1 minute 40 seconds from brakes off to 32,800 ft (10000 m) and the flexibility to operate from dispersed sites while generating a high sortie rate. Pressure refuelling through a single connection under the starboard wing can be undertaken with engine running, and the whole aircraft can be turned around (fuel, weapons and servicing) by five men in 10 minutes. During service testing of the first production AJ 37 (37002) between 8 January and 20 December 1979, 2,100 proving missions were flown, including a 'sortie surge'. The target for this undisclosed period was 200 sorties, which many thought unrealistic, but the aircraft generated 401 sorties for a total of 328 hours 12 minutes, confounding all the doubters. It is believed that squadrons plan to fly 11 sorties over a 24-hour period during wartime.

The first of an eventual 149 JA 37s ordered by the Fv, 37301 '50', made its 47-minute premier flight on 4 November 1977 with Gösta Sjöström as pilot and was regarded as a pre-production machine in view of its contribution to the development programme centred on Saab's test aerodrome at Linköping. 37302's 1979 reliability testing, mentioned above, involved 18 pilots from the air force, FMV and Saab examining all aspects of combat effectiveness, maintenance and flying safety before first deliveries began to F13 on 25 June 1980. Working-up of the first squadron was interrupted in June 1981 when bench-testing of an RM8B revealed a vibration-induced fatigue failure in the new third compressor stage. Viggen deliveries were suspended to the second wing (F17) and F13 reverted to flying Drakens until the flying ban was lifted in October. Grounding of all Viggens was ordered for 10 days in January 1985 after a loose nut caused a JA 37 to crash as a result of control restriction. The cause was quickly traced to lack of quality inspection during manufacture and Viggens were cleared to fly after an examination for loose objects. More recently, JA 37s were grounded temporarily following the loss of two Viggens to turbine blade fatigue between 5 and 8 April 1990.

Export attempts

Saab delivered the 100th JA 37 on 20 August 1985 and the final Viggen of all versions was handed over to the Fv on 29 June 1990. The total of 329 orders was far short of the 831 foreseen when the programme was launched, and neither were there any exports to prolong the production phase. Naturally, Saab attempted to interest the Fv in upgrades and derivatives of the design and promote the aircraft in the limited arms markets which Sweden allowed itself. Only one such venture has been successful.

Greatest of the missed prospects was the Saab 37E Eurofighter. Not to be confused with the EFA which now bears this title, the original Eurofighter competition concerned 348 Lockheed Starfighter replacements required by Belgium, Denmark, the Netherlands and Norway (a figure which has now increased to 517). Leading contenders were the General Dynamics F-16 Fighting Falcon, Northrop (McDonnell Douglas) F-18L, Dassault Mirage F1E and the Viggen. Even before engineering and performance technical aspects were assessed, the Saab product was at a political disadvantage because of the question mark over the technical support which could be expected from a neutral nation if NATO were at war.

In addition, the planned mass production of F-16s for the USAF reduced its unit cost to $6.9 million, compared with the $7.7 million rock-bottom price of a Viggen. Despite rating its chances of success at only 8 per cent, Saab entered the competition early in 1974 with an offer of licensed production to Belgium and the Netherlands. In order to meet differing time-scales, three Viggen variants were offered, beginning with the AJ 37 for immediate supply, followed by an AJ 37 with RM8B powerplant and then the full production-standard JA 37. Cost offset proposals made by Saab included shares of an estimated 1,000 additional export sales for which the Belgian and Dutch aircraft industries would provide parts. Both these and the Eurofighter were stillborn after all four customers agreed in 1975 on a joint F-16 programme.

This was not the first time that Norway had looked at the AJ 37, as a proposal to adopt Sweden's air defence radar system (STRIL) and compatible fighters had received con-

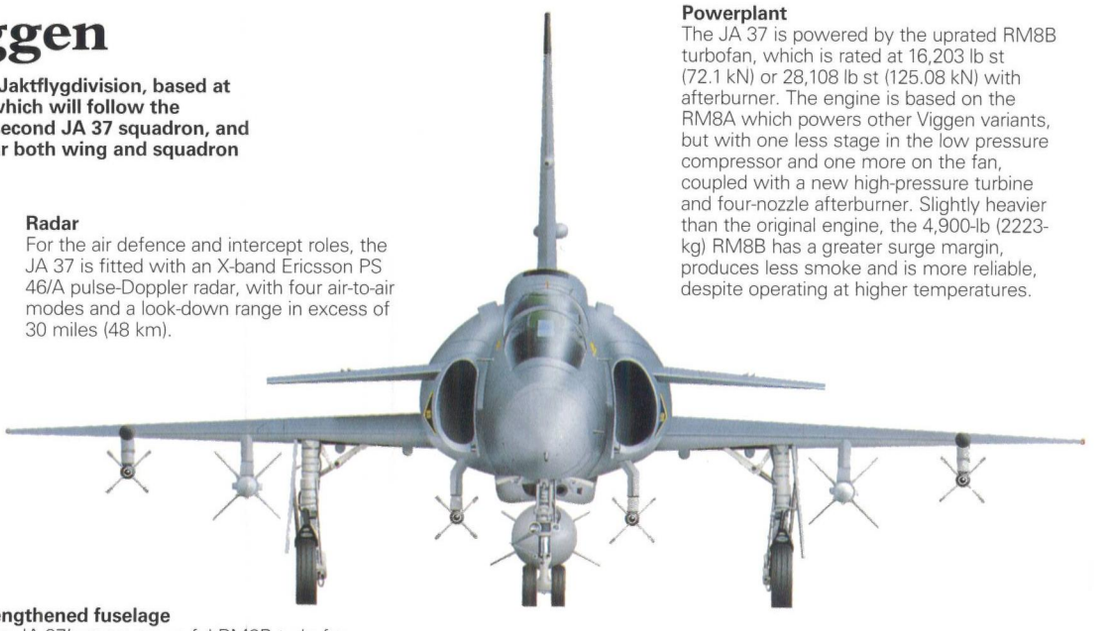
Saab JA 37 Jaktviggen

This fully armed JA 37 wears the markings of F17's 1 Jaktflygdivision, based at Ronneby. After the reorganisation of the Flygvapen which will follow the disbandments of F6 and F13, the wing will receive a second JA 37 squadron, and lose its recce unit to F10. Unusually, F17's JA 37s wear both wing and squadron badges.

Markings
Grey JA 37s initially wore the wing identity and individual numerical code in black, but the individual identity is now applied in fluorescent Dayglo, and often repeated in giant numerals on the upper surfaces of the wing. This increases conspicuity and enhances flight safety during peacetime training. This aircraft carries the oak tree badge of F17 on its tailfin, and the eagle and acorn insignia of the 1st Squadron on the spine, aft of the cockpit.

Radar
For the air defence and intercept roles, the JA 37 is fitted with an X-band Ericsson PS 46/A pulse-Doppler radar, with four air-to-air modes and a look-down range in excess of 30 miles (48 km).

Powerplant
The JA 37 is powered by the uprated RM8B turbofan, which is rated at 16,203 lb st (72.1 kN) or 28,108 lb st (125.08 kN) with afterburner. The engine is based on the RM8A which powers other Viggen variants, but with one less stage in the low pressure compressor and one more on the fan, coupled with a new high-pressure turbine and four-nozzle afterburner. Slightly heavier than the original engine, the 4,900-lb (2223-kg) RM8B has a greater surge margin, produces less smoke and is more reliable, despite operating at higher temperatures.



Lengthened fuselage
The JA 37's more powerful RM8B turbofan necessitates a small fuselage stretch (of some 4 in/10 cm), immediately ahead of the wing.

Canopy
The Viggen's swollen spine and prominent canard foreplanes restrict vision behind and below, but the blown canopy and frameless windscreen give an excellent view in the forward hemisphere, and even over the long nose.

Strip light
The Viggen is fitted with low-intensity strip lights on the engine intakes and fuselage sides. These are used as an aid to formation flying.

Tailfin
The JA 37 uses the same increased area tailfin as the two-seat Sk 37. The tip is taller, and swept back, and the leading edge of the fin is extended forward above a new leading-edge pitot, giving an extraordinary dogtooth effect.

With its huge canard foreplanes, the Viggen looks extremely modern, although unlike the canards fitted to current generation fighters they do not destabilise the Viggen, which employs a conventional electro-mechanical control system.

This F17 JA 37 was displayed at Berlin's ILA 92 air show, perhaps indicating a renewed marketing push in anticipation of surplus, retired Flygvapen Viggens becoming available.

sideration in 1967-68. The project was designated Saab 37X but did not progress as far as detailed design. The Australian Mirage III replacement competition which ran for most of the 1970s included a Viggen submission which lost out to the McDonnell Douglas F/A-18 Hornet, while a Japanese search for a new interceptor passed over the JA 37 in 1976 when McDonnell Douglas won with the F-15 Eagle. India's quest for a deep-penetration strike aircraft was then under way with the Viggen as a contender, until the SEPECAT Jaguar was chosen in 1978.

In 1975 Saab was engaged in studies of an advanced Viggen based on the JA 37 but optimised for ground attack. Initially known as System 85, it changed designation to A20 that year and received development funding in 1977 with a view to procurement in 1982-87 as a 'heavy' complement to the B3LA light attack trainer. However, B3LA was cancelled on 21 November 1978 and the offered replacement A 38/Sk 38 similarly followed it into oblivion three months later. That undermined the A20, which was quietly dropped shortly afterwards, although there was an attempt to resuscitate elements of the programme in the JA 37B. This less drastic adaptation of the Jaktviggen for ground attack was proposed for two squadrons, but the 1980 defence plan called for the Viggen force to be kept to the planned total of eight fighter, five and one-half attack and three reconnaissance Viggen squadrons, plus three squadrons of J 35 Draken interceptors. By then, the decision had been taken (on 20 February 1980) to order the JAS 39 Gripen as an eventual replacement for all variants of Viggen. No more were to be ordered, and even a suggestion that a dozen JA 37 attrition replacements should be funded in the mid-1980s was defeated.

Multi-role upgrade

It will be 2010 at least before the Gripen rules supreme in the Fv. First-generation versions of Viggen will be withdrawn before then, but to maintain their effectiveness into the next century they will be upgraded to AJS 37 standard from 1993 onwards. Announced in spring 1991, AJS 37 applies to 115 AJ, SF and SH 37s which will receive a new computer and digital databus to confer multi-role capability. They will also incorporate a terrain-following system. The result will be that the Viggen is capable of operating with some Gripen weapons, such as the RBS 15F anti-ship missile, BK/DWS 39 sub-munition dispensers, advanced AAMs and a new ECM pod to be delivered in 1993. Sweden's 1992-97 defence plan also calls for the JA 37 to receive new counter-

Dayglo orange individual aircraft codes have become common on Swedish air force fighters in recent years, because the air superiority grey colour scheme has proved too effective, and higher conspicuity is necessary for peacetime training.

measures systems but, on the down side, two Viggen wings disbanded in 1992, reducing the number of operating squadrons by two AJ units, one JA unit and one SF/SH unit.

By any standard, the Viggen is the current face of Sweden's air force. In offence or defence, its characteristic shape is to be found from the Arctic Circle to the temperate climes of the southern lakelands. Many NATO or former WarPac aircraft have been intercepted by a JA 37 over the Baltic Sea, and no less numerous have been the ships involuntarily posing for the S 37's cameras. Sweden has always been neutral on the Western side, but the presence of a Viggen has been a constant reminder to the world's major powers not to export their quarrels into Swedish waters or airspace. Now that central and northern European tensions have reduced, the Nordic Thunderbolt can rest more easily on its bed of clouds.

Left: After serving as one of the JA 37 development mules, the second prototype AJ 37 became the Viggen ESS, test-flying the triplex fly-by-wire control system designed for the JAS 39 Gripen.

This F13 JA 37 wears both wing badge (on the fin) and squadron badge (toned down on the fuselage, above the wing root). This squadron will join F17 at Ronneby in 1993, while the recce squadron moves to F10 (currently Draken equipped). F6 is to similarly lose its squadrons to F15 and F10 during 1993.

Saab Viggen Operators

Svenska Flygvapnet (The Swedish Air Force)

Sole user of the Viggen, Sweden's Flygvapen (Fv – Air Force) operates or is in the process of acquiring six versions of the aircraft, five of them (including conversions) from the first generation of the design. Immediately before reductions in strength were ordered in 1992 because of reduced international tension in Europe, 17 of the Fv's 20 combat squadrons were equipped with Viggens for attack, reconnaissance and air defence.

Despite this prominence in the front line, the Viggen failed by a significant margin to achieve the local production quantity initially envisaged. This was at one time set at 831 aircraft, although orders totalled only 329 production machines when deliveries were completed. The first order was announced for 100 Viggens on 20 March 1967, of which 17 were to be Sk 37 trainers and the balance to be single-seat AJ 37s for attack. On 5 April 1968 a further 75 machines were ordered, but in December 1973 it was revealed that sufficient savings had been made for a further five aircraft to be built within the same budget. Earlier that year an order had been revealed for the SF/SH 37 reconnaissance versions, although it was not immediately clear that they were to be taken out of the 175 (180) airframes then under contract. The second order was, in fact, amended to 22 AJ 37s and 53 recce aircraft until the supplementary machines increased this to 25 and 55. Types and serial numbers are: AJ 37, serials Fv37001 – Fv37108, quantity 108; Sk 37, serials Fv37801 – Fv37817, quantity 17; SF 37, serials Fv37950 – Fv37977, quantity 28; SH 37, serials Fv37901 – Fv37927, quantity 27.

These were preceded by a further eight prototypes, numbered 37-1 to 37-7 and two-seat 37800, and one aircraft (37071) which crashed before delivery and was replaced by an extra machine with the same serial number. Prototype SH 37 37900 was a rebuild of 37003 and does not count as new production, so that the number of first-generation Viggens was 189.

Manufacture of production Viggens of the first series took place between the initial flight of AJ 37 37001 on 23 February 1971 (or, pedantically perhaps, its roll-out in November 1970) and delivery of the last SF 37, 37977, on 1 February 1980. Service deliveries of Sk 37s began in June 1972, SH 37s in June 1975 and SF 37s in April 1977.

Jaktviggen interceptors, JA 37s, were first ordered in September 1974 when 30 were approved, together with a prototype and four (later five) rebuilds of AJ 37 prototypes to assist development. The R&D element of the order was granted Kr775 million in the 1974-75 budget. Approval for 60 more JA 37s came in May 1978, with Kr2,000 million voted in the 1978-79 budget. Early in 1980, the final order for 59 Jaktviggens, costing Kr2,642 million, was approved by the government. One hundred and forty-nine JA 37s had been produced, encompassing serial numbers Fv37301 – Fv37449.

Single new-built prototype was 37-8, assisted by 37-21, -31, -51, -61 and -71, which were rebuilds of 37-2, -3, -5, -6 and -7 respectively. Production took place between the first flight of 37301 on 4 November 1977 and delivery of 37449 on 29 June 1990. With the addition of 149 second-generation aircraft, Viggen production was increased to 339, comprising nine prototypes, 329 for Fv service and one replacement for a pre-delivery loss. The AJS 37 will enter service in 1993 as an upgrade of 115 AJ, SF and SH 37s.

Two separate chains of command link Viggen squadrons to Fv headquarters. Air defence and SF/SH 37 reconnaissance aircraft are attached to regional commands, while the AJ 37 attack Viggens form a separate air division under direct Air Staff control. Of seven Swedish regional Military Commands (Militäromräden), four have an attached Air Defence Sector with a total of six fighter/recce wings. In those sectors with two wings, the CO of one is nominated regional air defence commander. All four commanders also have at their disposal the STRIL 60 (Stridsledning och Luftbevakning) intercept control and early warning system, currently in the process of modernisation to STRIL 90 standard. Sectors and their wings are: **Luftförsvarssektor Ovre Norrlands** (Upper Norrland Air Defence Sector), HQ Luleä, Wing F21; **Luftförsvarssektor Nedre Norrlands** (Lower Norrland Air Defence Sector), HQ Östersund, Wing F4; **Mellersta Luftförsvarssektor** (Central Air Defence Sector), HQ Uppsala, Wings F16 (lead) and F13; **Luftförsvarssektor Syd** (Southern Air Defence Sector), HQ Angelholm, Wings F10 (lead) and F17 (F10 is equipped with Drakens).

Offensive elements, in three wings (10 Viggen squadrons and one of Lockheed Hercules transports), have been assigned to the separate tactical force, the Första Flygeskadern (First Air Division).

Each Air Wing (Flygflottilj) occupies a single base and, in addition to being numbered, carries the name of the *landskap* (regional district) in which it is located. Within the wing, each Squadron (Division) is numbered from '1' upwards and carries a title descriptive of its role, these being: Attackflygdivision – Air Attack Squadron; Jaktflygdivision Air Interceptor Squadron; Spaningsflygdivision – Air Reconnaissance Squadron. Wings are normally completed by a Helikoptergrupp (Helicopter Flight) for SAR and a Sambandsflygrupp (Communications Flight) of light or medium aircraft. The exception is F13, which has two Viggen squadrons and a detachment at Malmslätt for target facilities (Saab Lansen) and Elint (Sud Caravelle, being replaced by Gulfstream IV).

Identity markings comprise the wing number ahead of the national marking (three yellow crowns on a blue disc) with a yellow outer ring on the nose: yellow on green-camouflaged aircraft; black on those coloured grey overall and on early deliveries in natural metal. Prior to camouflaging, early production aircraft had wing identities on the air intake, which now carries FARA (danger) warning markings. Within each wing, aircraft wear a tailcode between 01 and 69 (70-99 being reserved for communications and support machines). Red figures are applied to Viggens in the green finish; black to those in grey camouflage. Most wings using the AJ 37 and JA 37 try to match codes to the 'last two' of the Fv serial when that is below 69. Sk 37 trainers of F15 were simply numbered from 69 downwards on delivery, while the two reconnaissance varieties have several different coding ranges according to their operating wing, but within the overall plan that SH 37s have odd-numbered codes and SF 37s only even codes.

Radio callsigns for squadrons comprise the wing identification (a male Christian name in the Swedish phonetic alphabet) followed by a colour: röd (red) – 1 Squadron; bla (blue) – 2 Squadron; gul (yellow) – 3 Squadron. Centralised servicing makes the application of squadron badges inappropriate in many cases, but F17 does apply such insignia to the rear of the cockpit canopy in addition to the wing badge on the fin-tip. F13 also adds its wing badge to aircraft fins, but is the only other unit to apply any form of decoration. Anniversary colour schemes, nose art and even zaps are not to be found in the Fv. Squadron complements are 18 aircraft.

Serial numbers of Viggens follow the standard Fv pattern of five digits, the first two of which reflect the type number (37). Blocks of serials are reserved for each sub-variant, the numbers being applied to the rear fuselage in small characters. Interchange of aircraft between wings is infrequent and tailcode numbers can remain unchanged for many years, even when aircraft are moved from one base to another.

A natural metal finish and black radome distinguished most production Viggens on their entry to service. This changed to a splinter camouflage – known as 'Fields and Meadows' – of three green tones plus brown for concealment when on the ground at dispersed sites. Lower surfaces were light gull grey during this period. Up to the end of deliveries, the Fv found it cheaper to accept Viggens in natural metal and paint them itself, a task it executed with remarkable uniformity. After an unsuccessful study of colours which might afford ground protection while being equally effective at medium altitude, JA 37s of F13 began in 1982 to experiment with schemes of overall white (on 37348 '38'), overall blue-grey (37329 '69' and 37350 '40') and overall extra light grey (37347 '37'). The answer was found to be a mixture of greys: fuselage light grey, while the radome, fin, all under-surfaces and top side of the wing are light gull grey. Repainting has been extremely slow, and by 1992 only half the JA 37 force had been relieved of its green and brown camouflage.

Below: High-visibility Dayglo code numbers and markings have been added to grey JA 37s to improve conspicuity in peacetime exercises. The diamond-shaped badge (left) is issued by Saab to all Viggen pilots (together with a scroll) and is known as the Viggen Order. The round badge is the Flygvapen equivalent.

Left: Very few camouflaged Viggens wear squadron markings, this JA 37 of F17 being an exception with its division badge on the spine.

Below: Awaiting painting by the air force, this newly delivered JA 37's codes identify it as an F4 aircraft.

when it, too, regained operational status. F4 was the fourth wing to receive the Viggen interceptor.

Västgöta Flygflottilj F6

Base: Karlsborg
Fin codes: between '01' and '58'
Badge: a lion salient and two stars on a black/gold diagonally-divided shield

1 Attackflygdivisionen
Equipment: AJ 37
Role: attack
Radio call: Filip röd
Badge: eagle upon a bomb

2 Attackflygdivisionen
Equipment: AJ 37
Role: attack
Radio call: Filip blå
Badge: cartoon bear

Established in 1939 with Hawker Hart bombers, F6 has remained in the attack role for over half a century, successively re-equipping with the Northrop 8A-1, Saab B 17, Saab J(A) 21, Saab Tunnan and Saab Lansen. During 1976-77, it became the third and final wing to convert to AJ 37s, a process delayed by the fleet grounding between October 1975 and March 1976. Maintenance training finally got under way late in July 1977 for 25 ground personnel who were detached to F7 until their course was completed on 4 November. 2 Squadron ceased Lansen operations on 7 October 1977 and the first group of its pilots reported to F7 on 17 October for theoretical training and simulator experience. Wing Commander Gunnar Hovgard collected the first Viggen from Saab on 7 November, although the first training sorties at F6's home base were on Sk 37 two-seaters borrowed from F15 and used from 14 November. The second batch of trainees began their ground school at F7 on 9 November and returned to F6 after type conversion on 10 March 1978. 1 Squadron ended F6's 97,320-hour association with the Lansen on 16 February 1978 and began a month of theoretical and simulator training four days later. Conversion of 2 Squadron was completed on 30 June 1978, while 1 Squadron was similarly declared operational on 31 March 1979. By November 1987, after 10 years of Viggen flying, F6 had accumulated over 18,000 hours of airborne time. The wing will disband in December 1993 as the first victim of defence cuts resulting from lowered tension in Europe, and its aircraft will be transferred to F10 and F15 or scrapped.

Left: Grey-painted JA 37s initially wore black unit and individual aircraft codes, as seen here. The overall effect was if anything too effective, and ways had to be found to make the aircraft more conspicuous.

Right: A formation of four AJ 37s of F6 is seen low over the sea. Ship-killing is a primary Viggen role, using a variety of guided missiles.

Below: All camouflaged Viggens wear red tailcodes, although these can fade to a near-yellow. The two-digit code is an individual identification within the wing.

Jämtlands Flygflottilj F4

Base: Ostersund/Frösön
Fin codes: between '26' and '69'
Badge: an elk, wolf and bird

1 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: David röd
Badge: a dragon

2 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: David bla
Badge: elk's head on a blue 'D'

F4 formed in 1926 and operated the CFM S.21 and Fokker C.V in reconnaissance roles before converting to Hawker Hart bombers in 1936, followed by the Northrop 8A-1 and Saab 17. A fighter wing since NA Mustangs were received in 1947, the unit has subsequently used DH Vampires, Saab Lansens and Saab Drakens. Deliveries of the JA 37 interceptor began replacing 1 Squadron's Drakens in August 1983, allowing it to be declared operational in July 1984. The J 35Ds of 2 Squadron were similarly replaced by April 1985 (many finding their way to the Austrian Air Force)

Skaraborgs Flygflottilj F7

Base: Såtenäs
Fin codes: between '01' and '60' for AJ 37
Badge: a lion salient on a black/gold divided shield

1 Attackflygdivisionen
Equipment: AJ 37
Role: attack
Radio call: Gustav röd
Badge: grippen (half man, half bird) on a red 'G'

2 Attackflygdivisionen
Equipment: AJ 37
Role: attack
Radio call: Gustav blå
Badge: grippen on a blue 'G'

3 Attackflygdivisionen
Equipment: AJ 37 (disbanded)
Role: attack
Radio call: Gustav gul
Badge: Rb 04 rocket on a yellow 'G'

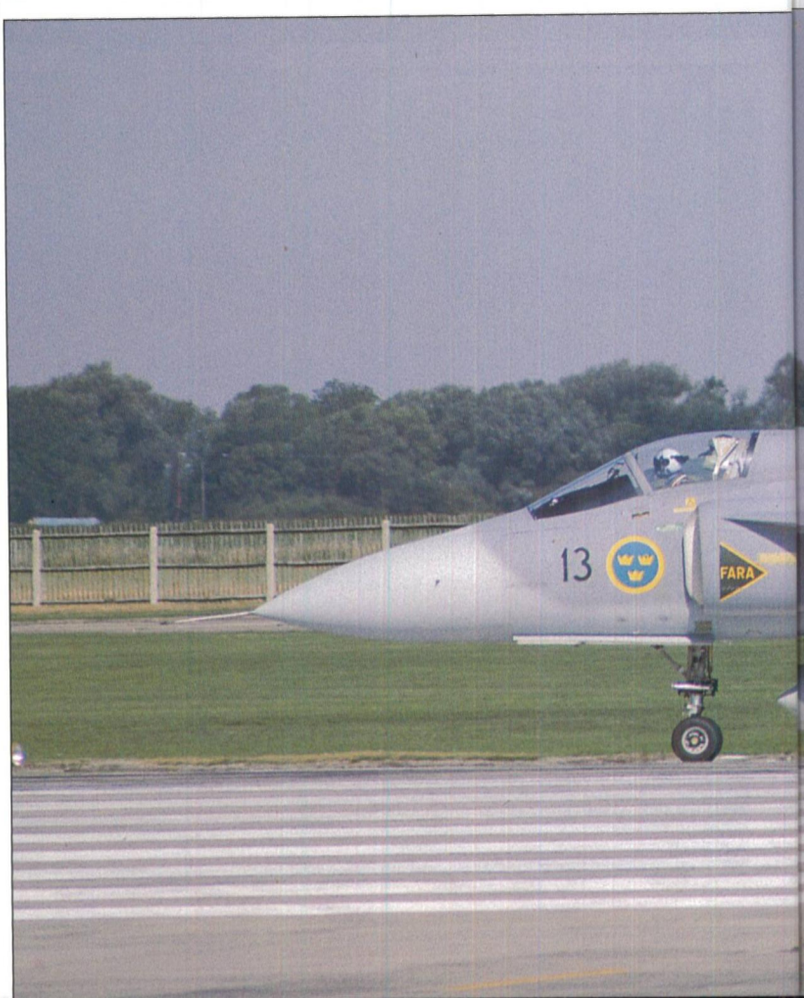
Apart from operating Caproni 313 bombers on formation in 1940, F7 has subsequently flown only Saab fighter-bombers to meet its combat commitment: B 17, J(A) 21, B 18B, J(A) 21R, Tunnan and Lansen. It was the first wing to receive Viggens, 2 Squadron beginning the training of its first pilots on 8 January 1973 with instructors who had undergone familiarisation at the Försökcentralen. For pilot conversion, Sk 37s were received from June 1972, 37801 to 37809 becoming '69' to '61' in reverse order. Two types of course were provided, of which Typinflygningen (TIS) was conversion to the aircraft, while Grundläggande Flygslagsutbildningen (GFSU) concerned itself with using the Viggen as a weapon. TIS took four months to cover 30 flying hours and 15 in a simulator, of which the first two 'live' missions were in an Sk 37. GFSU covered 70 flying and 15 simulator hours. In the first year of operations, F7 converted 40 pilots during 2,000 hours generated in 3,000 sorties. 1 Squadron was the second to receive AJ 37s, followed by 3 Squadron, the latter completing its re-equipment by August 1974. The wing's first loss occurred on 11 July 1974 when 37011 '11' was abandoned at about 8,000 ft (2440 m) after what was thought to be loss of control. The pilot, Sergeant Ola Gynäs, although he received only slight grazing, had no recollection of the incident, the possibility being that he blacked out due to high *g* and then ejected on regaining consciousness. When the Viggen OCU passed to F15 in December 1974, five Sk 37s were temporarily retained by F7 and recoded in the AJ 37 series. F7 experienced a further Viggen loss on 6 October 1975 when 37014 '14' broke-up during rocket-firing exercises on the Hattefuran range over Lake Vänern. Lieutenant Göte Pettersson ejected and was rescued by helicopter. The Viggen's wreckage was removed from the lake bed eight to 10 days later, and an engine explosion was initially suspected. Examination of the reconstructed airframe showed that this and 37011 (plus an F15 aircraft a few days later) had suffered catastrophic structural failure of the wing root, resulting in a six-month grounding order.

On 1 July 1977 3 Squadron disbanded and also transferred its equipment to F15. Delivery of SH 37s began for F13 on 19 June 1975 with 37901 '01', but early training in the reconnaissance role was undertaken under the auspices of F7 with the aircraft marked '7' on the nose until 1/F13 was ready to form in October 1976. In mid-1983, an F7 pilot had an unusual task to perform when an Rb 04 missile was withdrawn from stock at random for a quality test and fitted to an AJ 37 which then took off and destroyed an obsolete vessel of the Swedish navy.

While some natural metal Viggens wear yellow unit codes and red tailcodes, others, like this F7 Sk 37, wear them in black. F7 functioned as the Viggen operational conversion unit until December 1974, when the role passed to F15. The Typinflygningen course covered conversion to the aircraft, while the Grundläggande Flygslagsutbildningen course covered operational use of the aircraft.

Above: All Viggens seem to now wear 'Fields and Meadows' or air defence grey camouflage, unlike this early F7 AJ 37.

Below: F7 originally included two divisions (squadrons) equipped with the AJ 37, and one with the JA 37 interceptor.



Right: This F13 JA 37 wears high-conspicuity Dayglo orange markings, and carries the red eagle wing badge on the tailfin, in its proper heraldic frame, and a huge representation of the eagle's head badge of (Martin blå) on the side of the centre fuselage. Individual code numbers are often repeated on the upper surfaces of the wings, with one numeral of each wing.

Left: For many years, the Viggens of F13 were virtually unique in carrying a wing badge on their tailfins, as seen here.

Below: The SH 37 is a dedicated maritime reconnaissance platform, and is operated by F13's first division, alongside SF 37s.

Above: F13's 1 Spaningsflyg-divisionen operates the SF 37 (seen here) and SH 37 in the reconnaissance role.

Right: The second division of F13 operates JA 37 fighters. This camouflage has largely been replaced by air defence grey.

Bråvalla Flygflottilj F13

Base: Norrköping
Fin codes: between '01' and '27' (odd numbers only) for SH 37; between '02' and '20' (even numbers only) for SF 37; between '30' and '69' for JA 37
Badge: a red eagle, displayed
1 Spaningsflygdivisionen
Equipment: SF/SH 37
Role: reconnaissance
Radio call: Martin röd
Badge: Viggen front view
2 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Martin blå
Badge: eagle's head

Following formation in 1943 with FFVS J 22 interceptors, F13 became the first Swedish jet fighter squadron upon conversion to de Havilland Vampires in 1946. These were replaced by Saab Tunnans and Drakens. Conversion of 1 Squadron from interceptor Drakens to reconnaissance Viggens was begun with delivery of four SH 37s, including 37901 '01' in October 1976, following temporary assignment of the aircraft to F7 from June 1975. The first SF 37 (37951 '02') arrived at the squadron in April 1977. 1/F13 officially formed on 1 October 1987 with personnel provided by F11 at Kalle (mainly 4/F11, plus a few from 3/F11), which was in the process of running down as an S 32C Lansen unit. 2 Squadron continued to fly J 35F Drakens until its initial Viggen interceptor was received on 25 June 1980, making F13 the first wing to operate this variant. Pilot training was delayed by the grounding of JA 37s between June and October 1981 as the result of RM8B engine problems. During the flying ban, 2/F13 reverted to Drakens to keep pilots current, so it was not until 1 January 1982 that the squadron could be declared operational.

Hålsinge Flygflottilj F15

Base: Söderhamn
Fin codes: between '04' and '34' (AJ 37); between '51' and '69' (Sk 37)
Badge: a golden ram, salient
1 Attackflygdivisionen
Equipment: AJ 37
Role: attack
Radio call: Olle röd
Badge: Asterix the Gaul
2 Attackflygdivisionen/ Typingflygingskola
Equipment: Sk/AJ 37
Role: OCU
Radio call: Olle bla
Badge: Snoopy

F15 formed in 1945 with Saab J 21s as an interceptor wing and later operated de Havilland Vampires and Saab Tunnans. In 1960 it changed its role to attack when Saab Lansens were received. Conversion to Viggens was begun in 1974 when some of the Sk 37s previously used by F7 were accepted, allowing training of the wing's personnel to begin on 2 December that year. 2 Squadron completed conversion in 1976 and eventually received all the two-seat Viggens with which to provide TIS training, although 37812 '57' was an early loss when it crashed near Edsbyn on 15 November 1976. The most serious accident had occurred earlier, on 10 October 1975, when 37005 '05' broke up 12 miles (20 km) off Hornslandet, pilot Lieutenant Harald Gatel spending 20 minutes in the water before being rescued. This, and the loss of an F7 Viggen five days earlier, resulted in the fleet being grounded for six months for an investigation which led to discovery of a structural weakness.

Regarded as a half-squadron, 2/F15 remains an OCU, even for prospective JA 37 pilots who follow the Sk 37 element of the training course before learning the basics of the air defence Viggen on a simulator. Since late 1984, 2/F15 has converted some pilots straight from flying training, following a change in the previous Fv policy of accepting for the Viggen only those with 1,000 or more Draken hours. Unlike many air forces, however, the Fv does not regularly retrain and move pilots to different units (except when moved to slower aircraft or helicopters in their late 30s or early 40s) so the demand on the Sk 37's services is accordingly reduced. Additionally, pilots fly some 150 hours per year, compared with the minimum of 240 stipulated by NATO as necessary to maintain skills. Sweden's second Viggen wing was completed with the transformation of 1 Squadron in 1976. This has only AJ 37s on strength and is a regular attack unit. F15 will receive Viggens from the disbanding F6 during 1992 and is being reorganised in order to declare two full AJ 37 squadrons from 1 July 1993, instead of 1.5.

Upplands Flygflottilj F16

Base: Uppsala
Fin codes: between '01' and '36'
2 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Petter bla
Badge: lion on a Sidewinder above a regal orb
3 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Petter gul
Badge: Viggen over church spires

The Upplands Air Wing has been assigned to interception since established with FFVS J 22s in 1943. It then flew NA Mustangs, Saab Tunnans and Saab Drakens. 3 Squadron was first to convert to the Viggen, from autumn 1986, although the initial arrival (37319 '59') on 19 February that year was an aircraft loaned from F13 for maintenance training, despite being marked '16' on the nose. In 1987, 2 Squadron completed its conversion, having previously been the Draken OCU with Sk 35s as well as J 35Fs. The OCU's two-seat Drakens moved to F10 at Angelholm in October 1985, but during the time that F16 was stood down for conversion F10 provided a Draken detachment at Uppsala to maintain air defence coverage. (F16's 1 Squadron disbanded with Drakens – detached to Tullinge – on 1 July 1985.) F16 thus became the fifth and last wing to receive the Jaktviggen.

Above: F15's first division is an operational ground attack squadron equipped with the AJ 37. No distinctive unit badges are worn on the aircraft.

Below: F15's second division is regarded as a half squadron, because it includes a high proportion of two-seaters and functions as the Viggen OCU.

F16 at Uppsala consists of two divisions, each operating the JA 37 Jaktviggen. This aircraft carries a tiny representation of the 3 Jaktflygdivisionen badge, of a stylised Viggen over a church spire, on the tailfin.

Above: An SF 37 (identifiable by its camera nose) heads a line-up of F17 SH 37s. These reconnaissance Viggens equip the Ronneby-based Blekinge Flygflottilj's 2 Spaningsflydivisionen, but are due to transfer to F10 in July 1993.

Right: This F17 JA 37 was exhibited at Berlin's first international aerospace exhibition during the summer of 1992. Could this mean that surplus JA 37s might be offered for export?

Right: 1 Jaktflygdivisionen's badge is an eagle clutching an oak branch with a shield bearing the letter 'Q' (for Quintus province). It is worn on the aircraft spines.

Right: The second division's badge consists of triangles (representing the Viggen) over a gridded Baltic, encircled by a 'Q' of oak leaves.

Left: F17's oak tree badge is worn on the fins of the unit's JA 37s.

The flying suit badge is worn by pilots of the 1st Division.

Blekinge Flygflottilj F17

Base: Ronneby
Fin codes: between '03' and '49' for JA 37; between '51' and '69' (odd numbers only) for SH 37; between '54' and '68' (even numbers only) for SF 37
Badge: a figurative oak tree, charged on the trunk with three crowns
1 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Quintus röd
Badge: eagle and acorn sprig
2 Spaningsflygdivisionen
Equipment: SF/SH 37
Role: reconnaissance
Radio call: Quintus bla
Badge: two triangles above grid squares

The Junkers 86 torpedo bomber was the initial equipment of F17 when formed in 1944, a maritime connection continuing with the change to Saab 18s. F17 became the first Saab Lansen wing in 1956 and retained one squadron (No. 3) of the aircraft until it disbanded in 1975. Meanwhile Draken interceptors equipped the remaining two squadrons in 1973, 2 Squadron disposing of its last on 1 July 1978 and re-equipping with SF/SH 37s on 20 November 1978 as the second reconnaissance Viggen unit. Pilots came mainly from the rapidly disappearing F11, the third and fourth squadrons of which had already been denuded to equip 1/F13. F11 disbanded on 20 June 1979, effectively completing the replacement of S 32C Lansen and S 35E Draken by the two recce Viggen versions. In a different role, 1 Squadron became the second JA 37 operator when deliveries began on 12 December 1981. Re-equipment was completed in the spring of 1982 and the squadron gained operational status in September. On 15 January 1985 JA 37 37312 '12' crashed near Ronneby, although its pilot, Sergeant Anders Ericsson, ejected and was rescued by helicopter. Approaching base with the undercarriage down, Ericsson experienced restriction of the controls and an uncommanded roll to the left, which was found by post-crash investigation to be caused by a loose nut in the aileron system. All Viggens were grounded for 10 days and some 70 found to be similarly contaminated with nuts, bolts and fasteners. Theories of sabotage were discounted when it was discovered that these objects had adhered to sealants during manufacture and later broken loose after the sealants had dried.

Saab Viggen Operators

Norrbottens Flygflottilj F21

Base: Luleä/Kallax
Fin codes: '01' to '36' for JA 37; between '53' and '63' (odd numbers only) for SH 37; between '46' and '64' (even numbers only) for SF 37
Badge: crossed keys

1 Spaningsflygdivisionen
Equipment: SF/SH 37
Role: reconnaissance
Radio call: Urban röd
Badge: a cartoon wolf's head

2 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Urban blå
Badge: three Viggens over mountains

3 Jaktflygdivisionen
Equipment: JA 37
Role: air defence
Radio call: Urban gul
Badge: a swooping owl

HQ of F21 was established in 1941 as a sub-wing to operate transport and air ambulance aircraft, but no squadrons were formed until 1949 when No. 1 came into being, equipped with Saab 18s for reconnaissance. 1 Squadron subsequently gained NA Mustangs, de Havilland Vampires, S 29C versions of Saab Tunnan and the Saab S 35E Draken. When 2 Squadron formed with Saab Lansen fighters on 1 October 1961 (by the simple expedient of transferring a squadron from F12), F21 gained the status of a full wing, subsequently adding 3 Squadron in 1973, with initial equipment of Saab Sk 60 armed jet trainers. 1 Squadron became a Viggen operator on 1 July 1979, when it officially began operating both reconnaissance versions, and took delivery of the last SF 37 – and final first-generation Viggen – built (37977 '68') on 1 February 1980. 3 Squadron gained its first JA 37s in October 1982 (following 2/F13 and 1/F17) and was declared operational in the following July. Finally, 2 Squadron began receiving Viggens early in May 1985 and worked up to full operational status by April 1986. F21 thus became the largest Viggen wing with three squadrons dedicated to air defence and reconnaissance.

Försökcentralen

Base: Malmslätt
Fin codes: various
Nose code: 'FC'
Badge: nil

'Central Research' is assigned to proof and development flying for all Swedish military aircraft and has been involved with the Viggen throughout its flying career. The unit's markings were first applied to 37-5 'FC 05' from the prototype series, while first production AJ 37 37001 was delivered on 21 June 1971 to become 'FC 51'. Its short career ended during landing on 14 September 1971 when pilot Captain Lars Bandling applied reverse thrust in a cross-wind and the Viggen slid off the runway. Fortunately, Bandling was able to climb out of the burning aircraft. The next six, 37002 to 37007, joined the fleet as 'FC 02' to 'FC 04' and 'FC 15' to 'FC 17' but passed to other units when the initial training of instructors was complete. For this phase, the selected instructors were divided into two groups, the first, for the TIS type conversion phase, led by the former head of the Draken OCU, Captain Gunnar Ståhl. The second group comprised mainly ex-Lansen pilots who were to teach weapons training (GFSU phase) under Captain Karl-Göte Widén. Both groups began training early in 1972, a process completed in time for them to begin converting 2/F7's Lansen pilots from 8 January 1973. The FC also had the dubious distinction of losing the first Viggen in air force service when 37015 crashed near Malmslätt on 6 March 1973. 'FC 22' was the prototype Sk 37 (37800), while reconnaissance prototypes 37900 (SH 37 converted from the ex-FC AJ 37, 37003) and 37950 (SF 37) were also employed. 37950 was damaged in a ground collision at FC, going to F13 after repair. JA 37s have also been tested at FC, including 37308 '48'.

Saab-Scania Aktiebolag

Base: Linköping

Svenska Aeroplan Aktiebolag (Saab) formed in 1937 and was renamed Saab Aktiebolag (Saab Co. Ltd) in May 1965, although it merged with Scania-Vabis in 1968 and adopted its present title. The company's Aircraft Division has its factory and test airfield at Linköping, from where early prototype flying and regular production air-testing of the Viggen was undertaken. Two aircraft were lost in accidents before they could be delivered to the Fv: AJ 37s 37042 at Linköping on 9 October 1973 and 37071 on 27 August 1975. In the case of the latter, a subsequent airframe was given the same serial number and delivered to F7 with the fin code '02' as a replacement.

Above: One of F21's three squadrons operates the SF 37 and SH 37 in the reconnaissance role. Some of these aircraft wear a fin badge.

Below: With three full squadrons, F21 is the largest Viggen operator. This camouflaged aircraft is a JA 37 interceptor.

Above: This JA 37 wears the distinctive 'FC' nosecode of the Swedish air force test centre, the Försökcentralen. It carries IR-homing Sidewinder and semi-active radar homing Sky Flash air-to-air missiles underwing, with a centreline fuel tank.

Right: The Försökcentralen, as Sweden's main test and research centre, operates a mix of aircraft from its base at Malmslatt, including Viggens, Drakens and even a Lansen or two.

Left: After trials with overall white, overall pale grey and overall blue grey air defence colour schemes, this two-tone grey scheme was adopted for use on the JA 37. Black tailcodes were quickly replaced by codes in Dayglo orange.

VMA-124 Memphis Marines

Although it remains in front-line service with a number of air forces throughout the world, the A-4 Skyhawk is becoming an increasingly rare sight in its native American skies. The last combat survivors are the A-4Ms of the US Marine Corps Reserve, squadrons of which fly on towards an uncertain future – perhaps re-equipment with the F/A-18, perhaps disbandment. VMA-124 at Memphis seems likely to be the last A-4 unit, but its commander and pilots shrug off any pity with a proud affirmation that, in their hands at least, the Skyhawk still 'cuts it'.

Lieutenant Colonel C. L. Dockery is Commanding Officer of United States Marine Corps MAG-41, Detachment A. He joined the Marines as an enlisted man in 1965, doing time in helicopters and C-130s during the Vietnam War; stationed at Da Nang, he earned several Air Medals. Lieutenant Colonel Dockery went to Officer School (OCS) at Quantico. He assumed command of MAG-42's Detachment B in 1990 (re-designated MAG-41 Det A in 1992). His flying credits include 2,700 hours, a relatively small number due to the fact that he was enlisted for a number of years, then went to college, etc. Maintenance is now his speciality, which he cites as one of the most rewarding jobs in the Marines, but adds that it will "bring you to your knees at times" with frustration.

The A-4 Skyhawk 'M' models, or 'Mikes', are getting down to where there are very few spare parts left, the engines are old and the airframes are probably older than most of the pilots who are flying them. By mid-1992, there were four Marine reserve squadrons still flying the A-4M, VMA-142 at NAS Jacksonville, Florida, having transitioned to the F/A-18. The remaining units are VMA-124 at NAS Memphis, Tennessee; VMA-131 at NAS Willow Grove, Pennsylvania; VMA-133 (scheduled to deactivate in September 1992) at NAS Alameda, California; and VMA-322 at NAS South Weymouth, Massachusetts.

"The A-4 expertise has sort of melted away, so to speak. If you take a close look at my maintenance troops, most are senior types. We probably have some of the best A-4 experience anywhere in the world . . . our troops have been around the fighter most, if not all, of their careers. The engines (powerplants) are controlled by the training command. They are the biggest user of the A-4, with their TA-4Fs and Js. Another problem with the engines is the fact that they are the same as the EA-6B uses. They have priority over us because they are a front-line, critical part of the fighting force. They can save a lot of F/A-18s and A-6s!"

The mission of VMA-124 is to be a combat-ready squadron, ready to go at a moment's notice. The CO of the squadron is a reservist,

Above: Lieutenant Colonel Dockery poses beside VMA-124's mascot, a retired A-4M painted in the high-visibility colours once common on the Skyhawk.

Right: The aircraft with the '00' or 'Double Nuts' Modex is reserved for use by the MAG commander, although Dockery will take whichever jet is serviceable, such is his enthusiasm to fly.

air-to-air. Being a close support aircraft, we have to watch out for opposing fighters that will jump us and cause us to dump our ordnance prematurely, so there are certain parameters that we work within. If we get jumped, we'll turn into them to see if they are serious, as this happened many times in Vietnam; the MiGs would jump the F-105s just long enough to get them to release their bombs and then would run back north with their mission accomplished. If our adversary looks serious, a couple of our guys will release their bombs and take them on while the remainder of our formation will stay the course for the target. I have fought both F-15s and F/A-18s in the Philippines. They are tough at any altitude! If the A-4 stays below 20,000 ft we can stay even with the F-4s by running them out of gas, catching them on the way out or turning inside of them. But this new generation of airplanes – F-15, F/A-18, etc. – there is nothing you can do with them! It's fun to go out and tangle with them, but in about half a turn they are on top of you."

Ordnance loads

Dietrich: "When we go out on a CAX (Combined Arms Exercise) some of our A-4Ms will fly three or four sorties per day, with all types of ordnance loads: rockets, Mk 82 series, 20-mm, Walleye, Shrike, rockets, etc. The old 'Mike' can deliver them all pretty well with a great degree of accuracy. When going up against the F-16, it is very difficult to see it in time, due to its small size. If you do see it in time, it is hard to get an angle on it as it turns so well. The F-15 and F-14 are much bigger aircraft and they can't turn with the A-4, but if the latter two decide not to fight slow with you, then we have very little chance! We have to stay low and slow to survive and, in today's set of rules and tactics, slow is really not the way to go anymore."

Dockery: "We have done some extensive work out at the big base at Yuma, Arizona. We have really gotten into the low-level deliveries where we can survive on a Warsaw Pact-type battlefield. You come in as fast as you can and as low as you can. The Marines have designed some quick attacks where you are coming in working with an air FAC or ground FAC [Forward Air Controller], where they put some smoke or lasers on the target. You make one pass which, hopefully, you will survive (that is why it is so important to get your bombs on the target on the first pass), then you

Above: Three A-4Ms of VMA-124 (their skull and carsar bent wing insignia is shown inset) fly over Memphis. The city's famous pyramid is visible in the background.

Right: Lieutenant Colonel Dockery, CO of MAG-41, Detachment A, the parent unit of VMA-124, leads from the front in true Corps style.

Lieutenant Colonel Rick Travis, and the Executive Officer is Major R. F. 'Torch' Dietrich.

Dietrich: "In late 1977 or early 1978, the current A-4Ms were received into VMA-331 at Cherry Point as new aircraft. When that squadron stood down to convert to another aircraft type, the Ms went to another regular Marine squadron, before coming to the Reserves, and VMA-124."

Dockery: "The A-4M carries ordnance for both air-to-ground and

VMA-124 Memphis Marines

Left above and left: The A-4M can carry a wide range of ordnance, including unguided podded rockets, free-fall and guided bombs, CBUs and napalm. The aircraft pictured here carry rockets and napalm tanks, the latter still sometimes known as 'Shake'n'Bake', its tasteless Vietnam War nickname.

Above and right: A bombing range near Memphis, with the run-in prominently marked in orange, and a target of concentric rings. In the picture (right) one of VMA-124's A-4Ms can just be seen pulling off target (bottom right of photo), having scored a bull and a near miss.

Below: Four A-4Ms of VMA-124 make ready for a formation take-off.

Left: The A-4Ms of VMA-124 are in excellent shape, a glowing testament to the maintenance troops in the face of spares shortages and lack of funds.

egress out at low level and head back to reload. The A-4 is not an afterburner-type aircraft, but subsonic. We can nibble on Mach 1, but that's in a dive and we don't really want to be there! At some of the summer exercises, we carry a variety of ordnance to work the targets over and we are very good at it. I have only dropped one 1,000-lb bomb in my career. Most are in the 500-lb class. Even the 250-pounders are not very effective anymore. We are also capable of shooting a Shrike while working a 'Wild Weasel' operation. Some of the best ranges to work with are out at Fallon (Nevada) and Yuma (Arizona). The marine air wing that we are governed by requires that we stay about 75 per cent CRP [combat-ready pilot qualification], which is an ambitious goal for any reservist squadron. Our squadron, from time to time, has participated in Red Flag and we are always the bombers.

Range work

"The mission flown when we took the aerial pictures was a 'circle the wagons' type with a fixed target. We had to fly about 150 miles down into east/central Mississippi. We have to go a long way to the ranges that are available to us. We use the one in Mississippi and over near Fort Smith, Arkansas, a lot. One of the mission types that we have gotten very good at is working with an FAC in the standard 'Nine Line Brief' that allows us to work with any of the services. It is a standardised brief that just about all the services have now where we can roll in and work close with them. It just goes down the line and tells you the essential information you need, what type of target, the IP [Initial Point] they want you to hit, the distance from the IP, the heading, where the friendly forces are, and gives you a restricted heading to attack from so you won't be firing into friendly forces, and then it'll tell you how to get out of there. He'll either mark the target or point out a prominent terrain feature.

Precise flying

"Going down to the target in Mississippi, we flew down at about 23,000 ft, descended down into the target in a racetrack pattern where we are really working on our technique. Everything we do on the deep air and close support missions is with all the fancy timing, hugging the ground, getting there and popping up into the attack. We do not have all the sophisticated computers that the newer fighters do, so we really have to watch our dive angles, airspeed, whether or not we're wings level, etc. We do have some updated systems in the 'Mikes', but they are getting harder and harder to maintain because our tech reps are fading out on us, with many doing time in Kuwait and the Middle East. When all of the

systems fail, a good A–4 pilot can be so good with his aircraft that he can manually hit just about anything. You can come in on a target and look out of the cockpit and see the picture you have seen many times, whether through the gunsight or windscreen, and everything just looks right. I have found that to be very true when I was flying twice a day. I really didn't need the gunsight. If you don't fly on a frequent basis, you can lose this edge.

Keep them flying

"We are also very concerned about our safety record. In this day and age, when you break an A–4, there are no extra ones to be brought in to replace them!"

Right: For VMA-124, part-time doesn't mean unprofessional. Here Lieutenant Colonel Dockery leads two wingmen in a perfect vic formation. All of VMA-124's aircraft wear a drab toned-down grey camouflage, without unit markings.

Inset below: A colourful visitor to NAS Memphis, this TA-4 belongs to one of the training squadrons at NAS Corpus Christi. The Navy's training command is the biggest user of the A-4, and manages the overhaul and repair of all engines.

Below: Before the dramatic round of cuts which accompanied the end of the Cold War, the pilots of VMA-124 could have looked forward to conversion to the F/A-18 or AV-8B. Now they may be close to the end of the line.

McDonnell Douglas A-4M Skyhawk II

This Rockeye- and fuel tank-laden McDonnell Douglas A-4M Skyhawk carries the '00' ('Double Nuts') Modex of the MAG Commander, Lieutenant Colonel Dockery, and carries his name and tactical callsign ('Buzzard') under the canopy rail. VMA-124, nicknamed 'Whistling Death', operates from NAS Memphis as Detachment A of the Dallas-based reserve MAG-41.

External fuel
The carriage of external fuel tanks is almost *de rigueur* these days, with either a single tank on the centreline or two tanks underwing. These are normally of 400-US gal (1514-litre) capacity.

Tailplane
The all-moving tailplane is actuated by an electric screwjack for trimming, and incorporates hydraulically-powered elevators.

Powerplant
The A-4M is powered by a single 11,200-lb st (49.84-kN) Pratt & Whitney J52-P-408 engine, making it the most powerful US Skyhawk variant, and prompting the adoption of the name 'Skyhawk II', or the nickname 'Super Mike'. The earlier A-4E had an 8,500-lb (37.82-kN) thrust engine, and the original A-4F had a 9,300-lb (41.38-kN) thrust powerplant (although 100 of the latter were retrofitted with 11,000-lb (48.95-kN) J52-P-401s). Extra thrust gave the A-4M a 50 per cent improvement in climb and a 25 per cent improvement in take-off performance.

ARBS
Many A-4Ms were retrofitted with the same Hughes Angle Rate Bombing System (ARBS) as is fitted to the AV-8B. This consists of a combined laser and TV camera which measures slant range and the rate at which target angle changes to precisely fix the target position.

Tailfin
The A-4M had the same revised tailfin as the Israeli air force A-4H, though it was topped by a new 'hot dog' ECM antenna fairing. The rudders of most Skyhawk variants have distinctive external stiffening. Below the rudder is a navigation light and a plethora of radar warning receiver antennas. The prominent tubular fairing below the jetpipe houses the braking parachute. This aircraft carries VMA-124's 'QP' tailcode.

Cockpit
The A-4M introduced a new, redesigned cockpit canopy, which gave improved helmet clearance (a boon for tall pilots) and better all-round visibility. The aircraft was fitted with a McDonnell Douglas IG-3 zero-zero ejection seat.

Dorsal hump
The A-4M features the same avionics fairing as the earlier A-4F. New systems on the A-4M included the APN-194 radar altimeter, the APN-153(V) radar navigation system, the ARN-84 TACAN, APX-72 IFF, ARC-159 UHF radio and ARA-50 UHF direction finder.

Avionics
The A-4M introduced a whole new avionics suite, with upgraded ECM, APG-53A terrain clearance radar, ASN-41 INS, and a Marconi Elliott AVQ-24 546 HUD.

Arrester hook
Betraying its origins as a carrierborne nuclear strike aircraft, the A-4 is fitted with a businesslike arrester hook below the fuselage.

Fuerza Aérea

In addition to providing the normal air forces required by the overall defence of the nation, Colombia's air arms have the added burden of fighting the large and powerful drug cartels that operate in the country. Consequently, the FAC features a sizeable fleet of helicopters and fixed-wing aircraft dedicated to counter-insurgency work, many supplied by the United States in recognition of Colombia's brave attempt to stem the flow of cocaine from its territory.

The spearhead of the FAC is Comando Aéreo de Combate No. 1 (CACOM-1) which operates a squadron of Kfirs and a squadron of Mirage 5s. Here an example of each flies in formation from their home at Base Aérea Palanquero 'German Olano'.

Left: A steady supply of surplus Cessna A-37Bs from USAF stocks has allowed the FAC to build up two squadrons of these useful COIN aircraft. At least four of the more recent deliveries have been to OA-37B forward air controller standard.

Colombiana

Photographed by Peter Steinemann

Below: The Comando Aéreo de Apoyo Tactico (CAATA) operates a large force of helicopters from Base Aérea Melgar 'Luis F. Pinto'. Among them is this Bell 212 from Escuadrón Aéromovile 513, armed with rocket pods for missions against the drug cartels.

Above: Recently retired from service is the Lockheed T-33A, which flew attack sorties with Escuadrón de Combate 312 at Base Aérea Apiay. The Colombian Shooting Stars were the first jets delivered to Latin America, supplied from March 1954. The squadron flew AT-33As, T-33As with underwing racks and four RT-33As with camera noses.

Above: The Cessna A/OA-37Bs fly with two squadrons of CACOM-3 at Base Aérea Barranquilla 'Base Aérea del Atlantico'. This example displays the old colour scheme – a new scheme with low-visibility markings has been introduced.

Left: Escuadrón de Combate 212 is the Mirage 5 operator with CACOM-1. Its aircraft have been updated with some Kfir features while retaining the Atar engine. This was the first modified aircraft, with Elta EL/M-2011 radar, canard foreplanes and bolt-on refuelling probe for use with Kfir buddy tankers.

*Right: Specialist Mirages delivered to Colombia were two 5COR**s** with reconnaissance nose, and two 5COD two-seaters (illustrated) for conversion training. These have since been updated with canard foreplanes, and have been joined by two Kfir TC-7 two-seaters.*

Below: The status of the Mirage upgrade programme is unknown, but some remain in basic 5COA standard. Fourteen of these radar-less fighters were delivered from March 1972 onwards.

Comando Aéreo de Combate No. 2 (CACOM-2) is located at Base Aérea Apiay 'Luis F. Gómez Niño', and has three squadrons dedicated to counter-insurgency work. Escuadrón del Operationes Especiales 314 has a fascinating duo comprising the Douglas AC-47 gunship (left) and the FMA IA-58A Pucará (below). Two of the former serve with the unit, distinguished by their low-visibility gunship-grey scheme and airflow deflectors around the door. Three Pucarás were delivered in December 1989 as a gift from the Argentine government, donated to Colombia to help in the drug war.

Above: Colombia ordered the Kfir as long ago as 1981, but this contract was cancelled. The order was resurrected in October 1988, and covered 11 Kfir C-7 single-seaters and a pair of Kfir TC-7 two-seaters. The last was received in August 1989. Part of the deal with Israel involved the supply of Rafael Python 3 air-to-air missiles, as carried by this machine. Kfirs serve as part of CACOM-1 with Escuadrón de Combate 213 at Palanquero. One of the unusual tasks is to serve as buddy tankers, pending the receipt of a tanker-configured Hercules, a conversion reportedly being undertaken with IAI assistance.

Above: CACOM-2's Escuadrón de Combate 313 operates T-37Cs from Apiay on COIN work (note the underwing hardpoints). This aircraft has considerable repair work to the wing root/ engine fairing, the result of damage sustained during a low-level attack on a guerrilla stronghold. Eight T-37Cs are believed to remain in service.

Right: The Comando Aéreo de Transporte Militar (CATAM) is at Base Aérea El Dorado at Bogotá. Among the subordinate units is the Escuadrilla Presidencial which flies this Boeing 707-373C.

Below: Also with the presidential flight is this Fokker F28 Series 1000, delivered in 1971.

Right: An immaculate FAC veteran seen at Base Aérea Madrid, where most maintenance is carried out, is this ex-US Navy Douglas C-117.

Below: Douglas C-47s are still in widespread use as transports. This example is based at Apiay and used for resupplying army outposts in the Llanos.

*Inset, above: An unusual type to be found in **FAC** service is the **IAI-201 Arava**, three of which were supplied in 1980. They fly with **CATAM's** Escuadrón 712 alongside C-47s.*

*Left: The **FAC** operates the para-military airline **SATENA** (Servicio de Aéronavigacion a Territorios Nacionales) from a main base at El Dorado International Airport at Bogotá. Among the fleet are five **CASA C.212-200s** and three C.212-300s. The Series 300 illustrated is based at Villavicencio to serve the Llanos district.*

*Above: The ubiquitous Hercules provides **CATAM** with its main transport capabilities, the aircraft serving with Escuadrón de Transporte 711. Three Canadian **C-130Bs** were the initial equipment (from 1969), but all were lost in accidents during the programme to exploit the country's interior. Two C-130Hs arrived as replacements in 1984, and have since been joined by three ex-**USAF C-130Bs** in 1989. Reports suggest that at least one of the Hercules is to undergo conversion at **B.A.** Madrid to tanker configuration to support the fighter force.*

*Right: The **FAC** has a sizeable fleet of disparate aircraft types for VIP and staff transport duties within the nation and to neighbouring countries. This Cessna 550 Citation III flies with Escuadrón de Transporte 713 at El Dorado/ Bogotá on VIP duties.*

*Above: At the lighter end of the **SATENA** fleet are two Cessna 208 Caravans and three Pilatus PC-6/B2-H2 Turbo-Porters (illustrated). This machine is based at Cali, and serves small communities in the coastal region.*

*Right: A total of five Hawker Siddeley HS.748s was delivered to **SATENA** to operate domestic passenger services from Bogotá. Two survive, this being an HS.748-371 Srs 2B with a cargo door, first delivered to Colombia in 1981.*

Fuerza Aérea Colombiana

Left: The CAATA is the main helicopter group, based at Melgar. Among the units is Escuadrón Aérotransporte 512, which flies the Sikorsky UH-60A Black Hawk. Five were supplied in 1987, three in 1988 and at least two more by 1990. These have been funded by the US government and are used directly in the anti-drug war. The ability to insert teams of troops is highly useful in this style of warfare.

Right: Escuadrón Aéromovile 513 operates various Bell UH-1 variants from Melgar, including UH-1Bs, UH-1Hs and Bell 212s. This is an H model, the red panels indicating a pilot training role.

Left: A few aircraft in the Fuerza Aérea Colombiana inventory have come from confiscations from the drug barons. This is one such aircraft, a Bell 206B JetRanger based at Base Aérea Madrid with the presidential flight.

Right: Helicopter training is undertaken by Escuadrón Helicoptero 614 at Base Aérea Cali 'Marco Fidel Surez', the principal FAC training base. A pair of Hughes 300Cs remains with the unit, but the main helicopter trainer type is the Hughes 500C, of which five are in service.

Inset, right: Still believed to be part of the CAATA line-up, four Bell OH-13s fly with Escuadrón Entrenamiento 514 at Melgar. These veterans have a liaison role within the helicopter group.

Right: While the fixed-wing equipment of the Escuadrilla Presidencial is based at El Dorado, the rotary-wing element is based at Base Aérea Madrid. The principal VVIP helicopters are two Bell 412s delivered in 1985.

Above: Attached to CACOM-1, the Mirage/Kfir operating unit, at Palanquero, is Escuadrón de Transporte 214. Its sole equipment is this Piper Turbo-Cheyenne, which replaced a pair of Navajos which was destroyed in a hangar fire caused by the crash of a trainer.

Above right: An important recent addition for Esc. 511 is the McDonnell Douglas MD530MG, which can be armed with gun and rocket pods. These are known as 'Black Falcons', and a sizeable number are complemented by MD500MG Scouts and earlier Defender models.

Above: Highly active in the anti-drug war is CAATA's Escuadrón Aérotactico 511, which operates this Hughes OH-6A, recently returned to service after storage.

Below: CATAM's Escuadrón de Transporte 713 has a mixed fleet of light twins, which includes at least one Beech King Air 90. The usual home for this liaison/staff transport aircraft is Base Aérea El Dorado.

All training for the Fuerza Aérea Colombiana is undertaken by the Escuela Militar de Aviación (EMAVI) at Base Aérea Cali 'Marco Fidel Surez'. This has four squadrons handling primary, basic, advanced and helicopter training. The basic instruction is handled by Escuadrón Básico 612 operating the Beech T-34A/B Mentor, of which 15 are in service. Deliveries were 42 T-34As in 1954 and six T-34Bs in 1977.

Right: A single Beech D50 Twin Bonanza is on the strength of Escuadrón de Transporte 412. This unit is attached to CACOM-3, the A-37 operating group.

Below: Each of the three combat groups has a liaison and staff transport squadron attached. CACOM-2 at Apiay flies T-37s, AC-47s and Pucarás on COIN duties, but also has Escuadrón de Transporte 315, equipped with two Piper PA-31 Navajos (illustrated).

Primary training is undertaken by Escuadrón Primero 611 at Cali, this unit being equipped with the Cessna T-41D Mescalero. The original delivery of these was from October 1968 and covered 30 aircraft, 15 of which survive.

Right: Prior to the T-41 primary training phase, Esc. 611 screens students for suitability. The vehicle used for this is the IAR (Ikarus) IS-28B2 glider, built in Romania.

Left: EMAVI's Escuadrón Avanzada 613 flies five Cessna 310s on navigation and multi-engine training. Plans for the operation of Northrop T-38s in the advanced training role were cancelled, and advanced jet training is undertaken in the United States.

Right: The mixed liaison fleet of CACOM-3's Esc. 412 includes this single Beech 65-B80 Queen Air, seen here with engine running at Barranquilla.

***Left:** Supporting the tactical helicopter force of CAATA at Melgar is Escuadrón de Transporte 515. The squadron performs the liaison and light transport role, and is equipped with a pair of Cessna 210s. These aircraft feature retractable undercarriage, turbo-charged engine and weather radar in a fairing under the starboard wing.*

***Above:** In addition to the Twin Bonanza and Queen Air, Escuadrón de Transporte 412 operates this Piper PA-32 Cherokee Six from Barranquilla. Other miscellaneous types believed to be in service with the FAC include a Piper PA-34 Seneca, PA-44 Seminole, Cessna 340, Helio Stallion and Beech Baron.*

***Left:** The Grupo Aéreo del Sur is located at Base Aérea Tres Esquinas and flies a pair of de Havilland Canada DHC-2 Beavers on light transport tasks. Eighteen were delivered, along with four DHC-3 Otters.*

***Below:** Still flying at the weekends, this immaculate Boeing-Stearman PT-17 Kaydet is piloted by instructors from the EMAVI at Cali.*

Pave Hawk to the Rescue

Equipping three Air National Guard squadrons (the 102nd RQS in New York, 129th in California and the 210th in Alaska), and elements of the active-duty Air Force and Air Force Reserve, the HH-60G is the USAF's prime combat rescue helicopter, having taken over from the elderly HH-3E. Here Captain Riff Patton of the Alaska ANG describes the missions of the Pave Hawk, under both wartime and peacetime conditions, and also describes the unique features of flying the rescue mission in the Alaskan wilderness.

Pave Hawk to the Rescue

Above: Greatly enhancing the versatility of the HH-60Gs is a pair of Lockheed HC-130H(N) rescue support aircraft. In addition to providing communications, navigation, search and beacon-finding support, they are most valued for their refuelling capability.

"Our basic mission is combat rescue, and we train to perform the sort of mission they were involved with in Desert Storm. As part of that training we are capable of doing peacetime rescue, and we pull a 24-hour alert. We'll pick up anybody in need, either in the civilian community or the military community, but our priority is to the military.

"We have four HH-60 helicopters, known as the Pave Hawk, and we have two HC-130 refuelling tankers. The helicopters are configured with an internal aux tank that gives us about 3½ hours' worth of gas without refuelling. That's a great help to us given the size of Alaska. Assuming the tanker is configured with one Benson tank, that allows another 11,000 gallons to be passed on to us.

"In our combat role, we use night vision goggles on both the helicopters and the HC-130, and we're cleared down to 50 ft for training, depending on the illumination. That can be fun, with all the snow up here. We will be configured with two GAU-2 minis (Miniguns), but currently we have M60s. We'll normally try to employ a two-ship to give mutual support, with the tanker in a position where he can stand off – not in a threat environment but close enough to help us in case we need gas.

"We trained more with the A-10s when they had an air-to-mud role, but the ones up here now are OA-10s. We still train that SARTF (search and rescue task force) mission that was so popular and successful in Vietnam. For a long time the rescue community, as it dwindled down after Vietnam, was saying that it wasn't a viable option, and it certainly wasn't in a European scenario. But it was very beneficial that the training was continued, because it was obviously an excellent tactic in Desert Storm.

"As far as the combat mission goes, one of the first things that we like to address, long before an aircraft has gone down, is the whole intelligence scenario. If you ask a pilot in a SOF (Special Operations

Above: Equipped with four HH-60Gs, the 210th Rescue Squadron's lineage goes back to the 10th Rescue Squadron, established in 1946 at Elmendorf AFB and specialising in Arctic rescue techniques. The Guard unit received federal recognition on 4 April 1990, the first ANG unit in the 200-series. Its nickname is the 'Second Tenth', to reflect the reincarnation of the original Alaskan rescue unit.

Right: The 210th is part of the 176th Composite Group, which also controls the C-130H transports of the 144th Airlift Squadron. Both units share facilities at Kulis ANGS on Anchorage International Airport.

The first of the 210th Rescue Squadron's four Pave Hawks was delivered to Anchorage on 6 July 1990. At the time the aircraft were designated MH-60Gs, but they were redesignated HH-60G in the fall of 1991 to differentiate the combat rescue version from the Special Forces support machines.

Forces) environment how he'd go in and pick up a team and a rescue pilot picking up a survivor, hopefully both would have the same intelligence as to how the team got in trouble, or how the pilot got shot down. Depending on the intelligence, we have either pre-planned missions or launch-off-alert missions.

"In our imaginary scenario it could be either one, but we would like to know that, say, the pilot was one of four F-16s that were going in to strike a specific target and were facing specific threats. We'd like to have that intelligence before that strike occurred so that, if one does go in, we might know what shot him down. Hopefully we've already planned it to a point where we have an orbit point for the refuelling, a good point for the A-10s if they're going to provide coverage and maybe even an ingress route. Then we can start looking at whether we can degrade the threat so that it doesn't shoot us down. Are we going to go in with night vision goggles or are we going to use A-10s? Can we go in and just take out the threat with other aircraft? What assets are available to us? Can we use a B-52, or an F-117?! Is this a BAT-21 scenario or one in which I can get in with my helicopter and its guns and pick him up as fast as possible? In both Vietnam and Desert Storm we learned that the sooner you pick them up, the more 'liveable' the survivor is. There have been so many people that have been captured quickly.

"As for notification procedure, hopefully the guy had a wingman who was able to contact his tactical air control centre who, in turn, could alert the rescue co-ordination centre. They're the ones who will start the detailed planning and alert the 'Sandies' (rescue support attack aircraft) and the Herc [HC-130 tanker].

Flying low

"Once we're launched we have a number of options. We like to fly in low and we don't like to be seen, so if we can get in single-ship we might just do it. We prefer to go in as a two-ship just for mutual support, though. Sometimes we go in with the Herc and the A-10s, but it's a big, slow package. The Herc is vulnerable to SAMs and the other guys know you're coming. Now if we think we can get in more covertly by ourselves, and if we've got a GPS-modified helicopter, we'll say to the A-10: 'Meet you there!' Hopefully the A-10 has done his job in identifying the survivor, authenticating him and surveying the site, either from a FAC (forward air controller) point of view or for himself. He'll check that our intel is still current – for example, that the SA-7 which shot the guy down isn't backed up by 100 other troops. Then we'll go in. There could be another scenario, especially if I don't have a GPS-modified helicopter, where the A-10 will lead us in and show me right where the guy is. That's great, you just look down and there he is!

"Right now we don't have the capabilities to do this kind of rescue at night as the A-10 does not have night vision goggles, and they can't go low. At night it's strictly a two-ship with night vision goggles; 'alone and afraid' we call it. There may be two of us, but we don't have any real firepower – the guns just scare people. In the day it's different, we may have the full-blown four-ship of 'Sandies', and MiGCAP overhead. We're hoping to intermingle the capabilities for night work, so that it doesn't just have to be 'alone and afraid', but that's for the future.

"Preferably we'll go in and land. In Vietnam that wasn't an option because of the canopy, but it certainly was in the desert. However, a good friend of mine said you could fly for 10 hours on the terrain-following systems without a problem, but the most scary part was the last 10 ft of the landing,

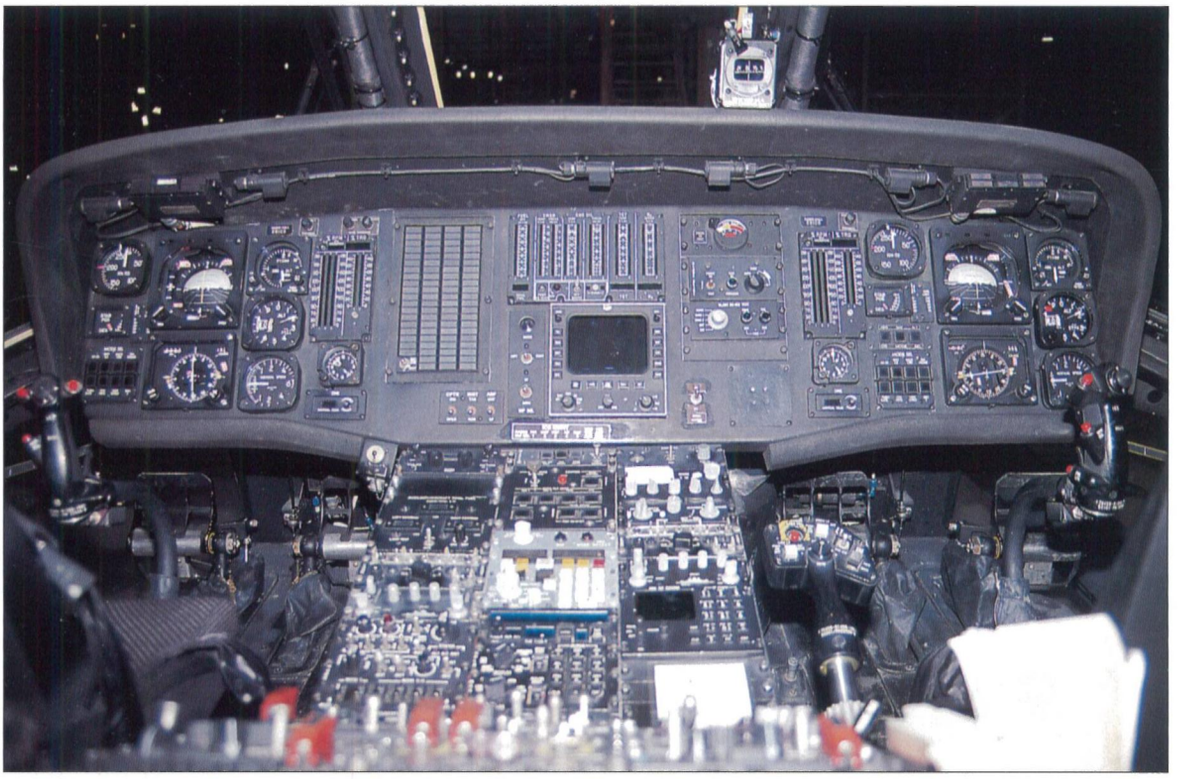
Mission equipment and a three-tone European One camouflage make the Pave Hawks appear considerably different from the plain Army Black Hawks. The serial numbers (88-26107 illustrated) are from standard Army Black Hawk blocks rather than from the US Air Force aircraft.

Sikorsky HH-60G Pave Hawk in detail

After various plans, including the abortive HH-60D and HH-60E variants, the US Air Force finally settled on the HH-60G to equip its rescue units, with the better-equipped MH-60G for the 55th and 71st Special Operations Squadrons. The HH-60s are distributed to various USAF bases with the active-duty Air Rescue Service, three ANG squadrons and the 939th Rescue Wing of the Air Force Reserve. A small number are in use with the 542nd Crew Training Wing at Kirtland AFB.

Above: The refuelling probe extends nearly to the point of clearing the rotor disc.

Below: This radome houses the Bendix-King 1400C colour weather avoidance/ground mapping radar.



Below: Attached to the hoist is a penetrator which incorporates strops and pull-down steps/seats for rapid extractions.

Above: The HH-60G cockpit is particularly well equipped for a helicopter. A second phase update will add two display screens.

Below: The capacious cabin houses the third crew station, which has communications and location systems.

because the sand was so difficult to see. But it's the best way for us – the lowest signature – and it's the quickest and easiest, especially if the survivor is immobilised in some way because of an injury.

Quick drop

"We also have a hoist, and we practise what we call a fast-rope. If the guy's down in the trees, we can fast-rope two pararescue men [PJs] down much faster than a rappel, and they don't have to wear a harness – they just slide down it. That way we can get them in, then depart the area and let them get set up and come back around for a hoist extraction.

"If it looks like a scenario where we can go in and hover, we'll do that, but we need to be careful because there's so much downwash on the survivors. The PJs don't like to work in it so we try to move off at least 100 yards. In general, we don't want to draw any attention to the survivor's location. We already have by going in the first time, but we're drawing more attention if we

The HH-60G rescue helicopter differs in detail from the full MH-60G SOF platform. The latter has an undernose turret housing a FLIR, although HH-60G crews regularly use night vision goggles. The MH-60G is more normally armed with the 0.50-in door gun, while the HH-60Gs have Miniguns or M60s. Funding may be found for the ANG machines to be brought up to MH-60G standard.

Lockheed HC-130H(N) Hercules in detail

Above: The flight engineer has a panel for controlling the HRU refuelling pods.

Left: The HC-130H(N) is based on new-build C-130H airframes, and benefits from having better systems than earlier HC-130 variants.

Below: Set into the rear ramp are tubes for launching flares to mark the position of survivors or for illumination.

stay there. So if we can go in, let the PJs off to do their work, go off and hide a little that's tactically better. We use either a time signal, or a beep on the radio, or secure radio if we have that as a call to go back in for the pick-up.

"In my opinion, the PJs are the most elite members of the Air Force. They're tremendously trained, tremendously fit. They train in scuba-diving, parachuting, both free-fall and static line, and various qualifications of Emergency Medical Technician. They're trained for survival in anything ranging from arctic to desert, mountains to water, and in marksmanship. The ones we have here had their initial training in the desert, but now they have the speciality of mountain and arctic work. Down at Moffett, our sister unit in California (129th RQS, California ANG) sent a lot of PJs to the war in the desert, and to Turkey to work with Special Ops MH-53s.

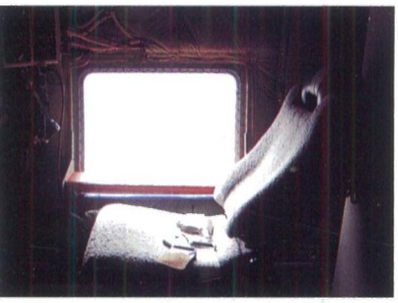
Civilian rescue

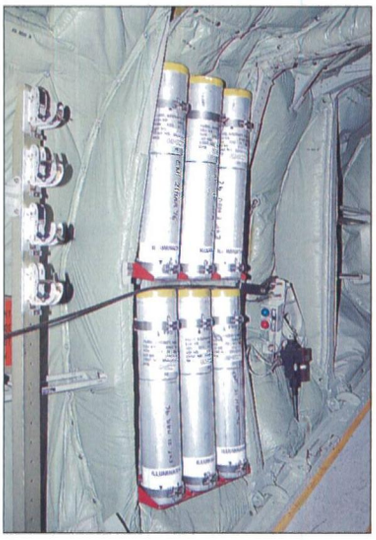
"Our peacetime rescue mission is mainly over land. The Alaska State Troopers are the ones who have jurisdiction over the Anchorage bowl, and they usually get the initial notification. It's all funnelled through the Rescue Co-ordination Centers – the land RCC is run by the Air Force at Elmendorf AFB, and the sea RCC is run by the US Coast Guard at Juneau. They co-ordinate all the rescue assets, military and civilian, and call on whatever they think is best for the job, whether it's us, a search dog team or a helicopter up in Nome. Anyway, the Rescue Co-ordination Center will talk to our search and rescue duty officer, and he'll decide whether we can launch – have we got good enough weather and things like that.

"Three weeks ago I went out to find a downed airplane. It had been flying through the Lake Clark pass in the evening, not quite dark. He'd ended up sneaking up the pass but not being able to clear through it and tried to turn round. He ended up 200 ft lower than where he thought he was and crash-landed on the lake. The SARSAT (search and rescue satellite) picked up an ELT (Emergency Location Transmitter) and this alerted the RCC. An hour later they got another ELT but there was no overdue flight plan called in. By the time they got this confirmation it was fully dark, with very strong winds forecast. The duty officer elected not to send us out then, but in the morning we went out. We tried to stay under the clouds but had to climb. The tanker launched and stayed up above. He picked up the ELT nice and strong, and we could find enough breaks in the clouds to get down into the pass, visually ID the survivors and pick them up. They were pretty happy to see us. Having the tanker with us gave us much more flexibility – they could find the survivors very quickly for us by flying higher and faster. They did a really good job getting to the pass with us.

"An awful lot of the SARSAT hits are extraneous – somebody testing their ELT or doing a hard landing which may set it off. In

The 210th RQS has three HC-130H(N)s assigned, the first of which was received on 15 October 1990. The unit is unique in operating this Hercules variant.



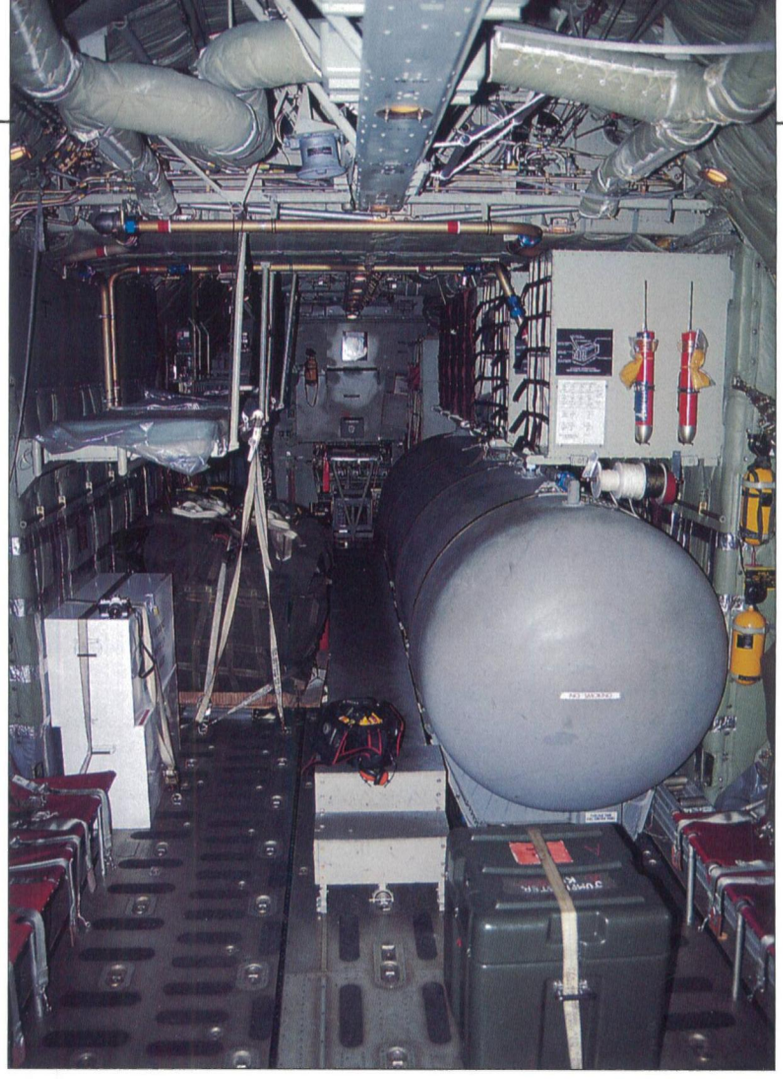


Left: In the forward cabin is a large observation window with an observer's seat. The sheepskin cover provides considerable extra comfort during long overwater search patrols.

Above: The HRU pods contain traffic lights in the tail to direct receiver pilots. Red means 'fuel pressure off', yellow means 'pod ready to give fuel' and green signals 'fuel is flowing'.

Left: Flares are stored on the cabin walls either side of the rear ramp.

Right: In normal configuration the cabin has one Benson auxiliary tank, although two can be fitted. Various rescue kits such as air-droppable dinghies and survival packs are carried, while stretchers are fixed to the sides.



general, we in the rescue community have started to go with double confirmation of the ELT. It takes about an hour to get good triangulation from the SARSAT, and by then you can start looking for the overdue flight plan.

"All our sea-bound work has already gone through the Coast Guard and they, for some reason, have declined it. Either they don't have a surface vessel they can get there, or their helicopters haven't got the range. The reason we're asked to go is the inflight refuelling capability. That allows us to extend way beyond land range – we commit ourselves to flying beyond a range from where we can get back to land unrefuelled. We need the tanker to get back. Once you get on-scene, the colour weather radar can paint ships well, and hopefully we can use that to identify the one in trouble. We also plot other ships just in case we get in trouble and have to ditch near one.

"We try not to commit the helicopters to sea search too much, as it's slow and because of the accidents that have happened, but the Hercs will go. The helicopters are good for concentrated search areas, but for a wide area the Herc is an excellent tool, and they're used a lot.

"In all our missions, the inflight refuelling is very important. It's a blast, I won't say it's better than sex but it is a lot of fun. It's the most challenging thing we fly. I have a friend who said that when he first started learning, you spent your time flying formation trying your best not to hit that other helicopter, but now they're teaching you to go out and hit something! Having the tanker there is great too from a navigational point of view. When you're in cloud you sometimes get into what we call the ping-pong ball effect – you're in the ball and you don't know which way is up or left or right. The tanker just sits there, a beautiful stable platform with much better navigation equipment – and he can give you gas when you need it, too.

"A package with one Herc and two helicopters can go out and be on-station for a long time. On some missions we need to take a second Herc, and those can go on past 12 hours. We refuel at 110 kt, and the Hercs do quite well at that. They don't like going any slower because of their weight. We can actually go up to 120 kt. One of the nice

Dispensing with the redundant Cook Aerial Tracker and Fulton STAR equipment of other HC-130 variants, the HC-130H(N)s are best identified by the underwing refuelling pods and the search windows.

Left: Alaska's impressive mountains make an excellent backdrop for an HH-60G approaching the Hercules for refuelling.

Right: Ski-pads are a regular sight on the Pave Hawks of the 'Second Tenth'. These increase the helicopter's footprint considerably, an advantage not only on snow but also on swampy ground.

Below: Just a few miles from the 210th RQS base at Anchorage is some of the harshest and most inhospitable terrain on the globe. Both the Pave Hawk and the 'Second Tenth' are masters of rescue in such conditions.

things about the Hawk is that it's a little speedier than the H-3. Over land we always refuel above 1,000 ft – we're not allowed to go under that. Mind you, there have been some missions over the water, where you know there are no obstacles, and the clouds go down to 400 ft, and the guys are hanging it out to get that gas.

"In combat things might be different. I don't know what they did in the desert but I think they went down to 500 ft. You have to analyse which is the biggest threat: the threat of a SAM or colliding with the ground."

Below: Refuelling is a formation-flying challenge for the HH-60 crews, while the HC-130 has to maintain 110 kt, right at the lowest part of its speed regime.

Sikorsky S-70/H-60

Part 2: Air Force and Navy Variants

Above: A pair of HH-60Gs from the 129th Rescue Squadron refuels in flight from a Lockheed HC-130P Hercules tanker from the same unit.

Right: Crewmen dangle their feet from the open door of a Credible Hawk UH-60A, now modified to virtual MH-60G standards and serving with the 1st SOW.

Air Force Variants

In 1981, after an internal review of available options, the Air Force concluded that its H-X requirement for combat rescue helicopters with which to replace Sikorsky HH-3Es in service with active and reserve components of the Aerospace Rescue and Recovery Service would best be met by ordering a derivative of the UH-60. Thus, using $36.6 million from FY82 funds, the Air Force instructed Sikorsky to initiate full-scale development of the HH-60D and ordered 11 UH-60As (81-23643/81-23647, 82-23761, 82-23680, 82-23689, 82-23708, 82-23718 and 82-23728) through Army channels with the intent of having one modified as an HH-60D prototype and another set aside for later conversion. The remaining nine Air Force UH-60As were intended as interim equipment for the 55th ARRS and were to be used to train HH-60D crews. As delivered beginning in December 1982, the Air Force UH-60As differed from standard Army Black Hawks in having **(1)** folding stabilators for rapid deployment aboard transport aircraft; **(2)** provision for retrofit of the Hover Infra-Red Suppressor Subsystem (HIRSS); **(3)** night vision goggle (NVG)-compatible cockpit lighting; **(4)** electrically-operated rescue hoist with a 600-lb/272-kg capacity (enough to lift a jungle penetrator, a pararescue jumper and his gear, and one or two rescuees); **(5)** a winterisation kit with main and tail rotor de-icing; and **(6)** a wire strike protection system. In addition, they were finished in USAF European One camouflage instead of being coated with dark green CARC (Chemical Agent Resistant Coating) as are Army Black Hawks.

When it initiated the development of the HH-60D, the Air Force first proposed an ambitious programme calling for the acquisition of 243 HH-60D Night Hawk adverse weather helicopters not only to replace Sikorsky CH-3/HH-3s and Bell HH-1/UH-1s serving in the rescue role with MAC, AFRES and ANG units but also to complement Sikorsky HH-53s serving in the special operations role with MAC units. However, fiscal reality soon led the Air Force to recommend instead the procurement of a mix of 89 HH-60Ds and 66 HH-60Es, the latter having a less complex avionics suite to reduce costs. Even this plan proved unrealistic and, in the spring of 1984, the Air Force proposed in its FY85 budget request to reduce its procurement of combat rescue/special operations helicopters to 99 HH-60As, these being HH-60D/HH-60E hybrids. To serve as a prototype for this new version, the HH-60D prototype was sent to IBM's Federal Systems Division to be fitted with HH-60A mission avionics. However, procurement of HH-60As could not be funded and the Air Force was forced to proceed with an even less ambitious three-step programme calling initially for the upgrading of its 10 UH-60As to Credible Hawk standard and the acquisition of nine additional UH-60As for similar upgrading. Later, the Credible Hawk UH-60As were to be brought up to MH-60G standard with additional comm/nav equipment and additional Black Hawks were to be procured for modifications to the MH-60G and HH-60G configurations. The MH-60Gs and, to a lesser extent, the HH-60Gs were to receive further improvements.

UH-60A Credible Hawk

Phase One of the Air Force UH-60A upgrade programme was primarily intended to extend range through the addition of a telescopic inflight-refuelling probe, auxiliary cabin tanks, and the incorporation of plumbing and wiring for eventual installation of either the ESSS or ETS external fuel tank system (all of which had earlier been fitted to the HH-60D prototype). Three cabin tank systems were developed and tested to meet different requirements, a pair of 185-US gal (700-litre) self-sealing tanks fitted against the rear bulkhead being favoured for special operations as it enabled the MH-60G to

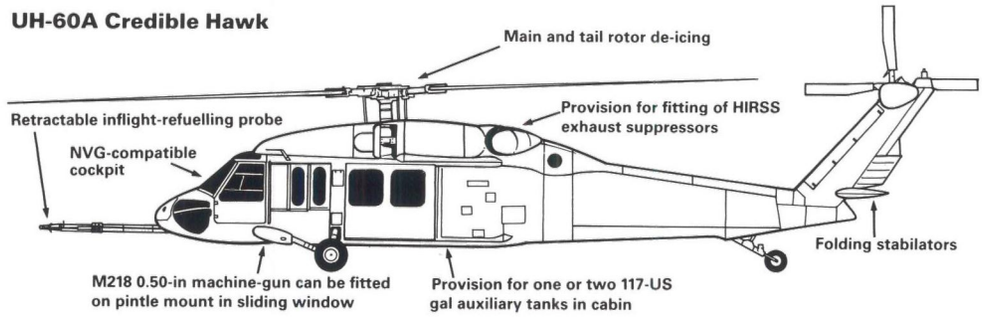
Right: The USAF's UH-60As originally lacked provision for inflight refuelling.

carry enough fuel for 4.5-hour operations and thus to be endurance-compatible with the MH-53J. However, this arrangement was found to reduce available cabin space excessively and for rescue operations the preferred system consists of a single 117-US gal (443-litre) tank installed flat in the rear of the cabin to leave room for fitting a litter above it; when greater range is required for rescue operations a second 117-US gal tank can be fitted. The Air Force also cleared its Credible Hawk UH-60As to carry and fire the 0.50-in M218 machine-gun, one of these guns replacing the standard Army M60 gun on a pintle mount at the sliding window on each side of the cabin.

The contract to upgrade UH-60As to Credible Hawk standard was awarded to Sikorsky Support Services of Troy, Alabama, on 31 December 1985 and called for initial installation and kit proofing with subsequent modification of two UH-60As per month. Work began on 30 May 1986, the first Credible Hawk was delivered on 3 February 1987, and the last from the initial batch of 10 UH-60As was completed in August 1987. Nine additional UH-60As (87-26006/87-26014) were procured by the Air Force for conversion first to Credible Hawk standards and then to Pave Hawk standards.

Air Force units operating UH-60As prior to and/or after the conversion of these helicopters to the Credible Hawk configuration were the 55th Aerospace Rescue and Recovery Squadron at Eglin AFB, Florida, and the 1551st Flying Training Squadron at Kirtland AFB, New Mexico. In addition, a number of MAC, AFRES and ANG units have flown some of their helicopters in the Air Force UH-60A configuration (i.e., prior to installation of the refuelling probe) until they could be cycled through the HH/MH-60G upgrade programme.

UH-60A Credible Hawk


Main and tail rotor de-icing
Retractable inflight-refuelling probe
Provision for fitting of HIRSS exhaust suppressors
NVG-compatible cockpit
Folding stabilators
M218 0.50-in machine-gun can be fitted on pintle mount in sliding window
Provision for one or two 117-US gal auxiliary tanks in cabin

A UH-60A of the 1551st Flying Training Squadron at Kirtland is seen prior to modification to HH-60G standards. HIRSS is already fitted to this aircraft.

A USAF UH-60A seen after conversion to Credible Hawk configuration. The semi-retractable refuelling probe is fully extended to project forward of the rotor disc.

HH-60A

Shortly after the HH-60D prototype entered flight trials, funding limitations prevented the Air Force from proceeding with its development and that of the yet-to-fly HH-60E. In their place, the Air Force elected to proceed with a single HH-60D/HH-60E hybrid version differing essentially from the HH-60D in dispensing with the expensive helmet-mounted display system and in having the TF/TA radar replaced by a less costly weather/ground mapping radar. As the HH-60D full-scale development aircraft (82-23718) had not yet been fitted with its mission avionics, it simply became the HH-60A prototype and was sent to Edwards AFB, California, for preliminary Air Force evaluation and testing of its rescue hoist.

Upon completion of this preliminary evaluation phase, 82-23718 was delivered to IBM to receive its avionics. Flight trials were resumed at Owego, New York, on 3 July 1985 and procurement was to have commenced in late 1985 with an initial order for three HH-60As. However, as noted earlier, funding for the HH-60A programme could not be obtained and the prototype was eventually sent to the Warner Robins Air Logistics Center in Georgia for storage.

Serials: 82-23718.

Right: The sole HH-60A (previously the HH-60D prototype) carried external tanks on outriggers beside the cabin.

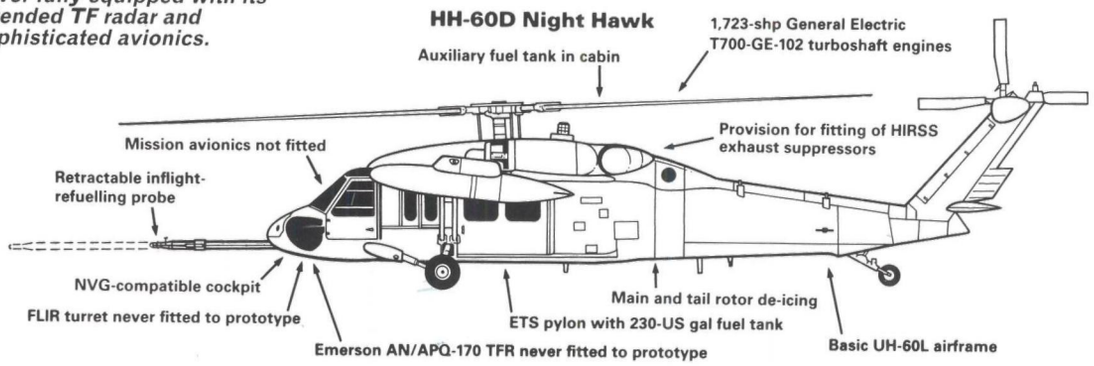
HH-60D Night Hawk

As originally proposed, the HH-60D was to differ from the UH-60A in being fitted with **(1)** 1285-kW (1,723-shp) T700-GE-102 engines; **(2)** the uprated transmission and main rotor brake of the SH-60B; **(3)** a telescopic inflight-refuelling probe on the starboard side, which, when extended, was to increase overall length from 64 ft 10 in/19.76 m to 68 ft 9.1 in/20.96 m; **(4)** the Extended Tank System (ETS) consisting of upward-canted stub wings to carry a 230-US gal (871-litre) external tank on each side; **(5)** provision for a 117-US gal (443-litre) auxiliary tank in the cabin; **(6)** an Emerson AN/APQ-170 digital TF/TA radar in a centrally-mounted nose radome; **(7)** an FLIR turret beneath the nose; **(8)** a moving map display; **(9)** helmet-mounted displays; **(10)** radar warning receivers, chaff/flare dispensers and IRCM pulsed jammer; and **(11)** armament including a 7.62-mm Minigun pintle-mounted at the sliding window on each side of the cabin, forward-firing Miniguns on fuselage side sponsons, and Stinger air-to-air missiles for self-defence. Mission avionics were to be installed by IBM's Federal Systems Division at Owego, New York, and Sperry was retained for developing new controls and displays.

Aircraft 82-23718, the penultimate UH-60A in the initial batch procured by the Air Force through Army channels, was modified as the HH-60D prototype and was fitted by Sikorsky with a refuelling probe, an auxiliary tank in the cabin and ETS stub wings with external tanks. Not yet fitted with its mission avionics, this prototype was first flown at Stratford on 4 February 1984. Shortly thereafter, however, the Air Force was forced to reconsider its intent to acquire a mix of HH-60Ds and HH-60Es, and 82-23718 was set aside to be modified as the prototype for the hybrid HH-60A version.

Serials: 82-23718.

Right: The HH-60D prototype was never fully equipped with its intended TF radar and sophisticated avionics.


HH-60D Night Hawk
1,723-shp General Electric T700-GE-102 turboshaft engines
Auxiliary fuel tank in cabin
Provision for fitting of HIRSS exhaust suppressors
Mission avionics not fitted
Retractable inflight-refuelling probe
NVG-compatible cockpit
FLIR turret never fitted to prototype
Main and tail rotor de-icing
ETS pylon with 230-US gal fuel tank
Emerson AN/APQ-170 TFR never fitted to prototype
Basic UH-60L airframe

HH-60E

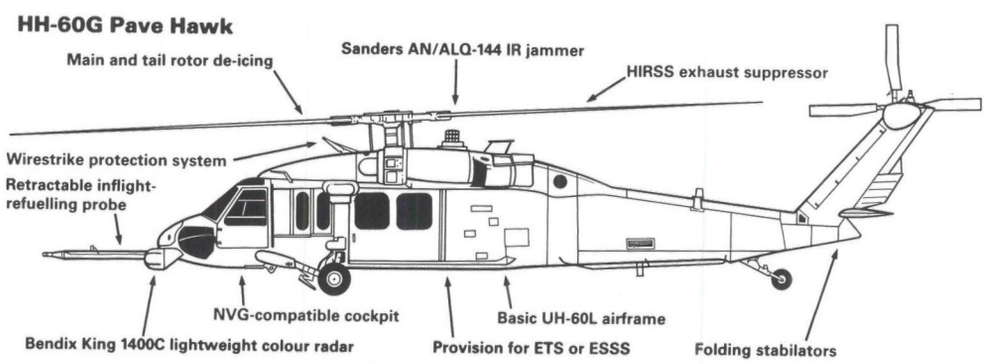
As the HH-60D would have been quite expensive, the Air Force proposed in late 1983 to reduce its HH-60D procurement from 243 to 89 aircraft and to supplement the HH-60Ds with 66 HH-60Es not equipped for adverse weather operations, costs being reduced by dispensing with the TF/TA radar, FLIR, moving map display and helmet-mounted displays as planned for night/adverse weather HH-60Ds. Even that mix proved too expensive and both versions were cancelled in favour of the proposed acquisition of HH-60As.

HH-60G and MH-60G Pave Hawk

Both initially designated MH-60G, these two Pave Hawk versions differ one from the other mainly in the status of their Phase Two and Phase Three equipment upgrades. The special operations MH-60Gs received priority over rescue HH-60Gs, the latter's designation being adopted in October 1991 to differentiate the SAR-dedicated version from that used for special operations. The MH-60Gs and HH-60Gs are basically UH-60As which are completed at Stratford with Air Force-specified modifications (folding stabilators, HIRSS, NVG-compatible cockpit, rescue hoist, winterisation kit and wire protection system), are brought to standard approaching that of the Credible Hawks (with refuelling probe, auxiliary cabin tanks and provision for ETS or ESSS) by Sikorsky Support Services, and then receive Phase Two and Phase Three equipment upgrades during modifications at the Naval Air Deport in Pensacola, Florida.

In order to keep costs to a minimum, the Air Force assigned responsibility for engineering work on Phase Two in the programme to modify UH-60As into special operations and combat SAR helicopters to the Warner Robins Air Logistics Center at Robins AFB, Georgia, and prescribed that comm/nav equipment to be installed as part of this upgrade had to be available off the shelf. Additional savings were to be achieved by having the equipment installed by the Naval Air Depot at NAS Pensacola rather than by a private contractor. Included in the Phase Two MH-60G upgrade were the installation of an Integrated Tactical Navigation System (ITNS), secure communications equipment and defensive systems. The ITNS integrates **(1)** a Bendix-King 1400C lightweight colour radar in a radome on the port side beneath the nose for weather avoidance, ground mapping and beacon operation; **(2)** an AN/ASN-137 Doppler; **(3)** a global positioning system; **(4)** a Carousel IV E inertial navigation system; and **(5)** a Teldix KG-10-20 map display unit. Secure communications are provided through the use of a data-burst unit, a Motorola AN/LST-5B satellite UHF communications transceiver, Collins HF radios and a Cubic AN/ARS-6(V) personnel locator interrogator and guidance system

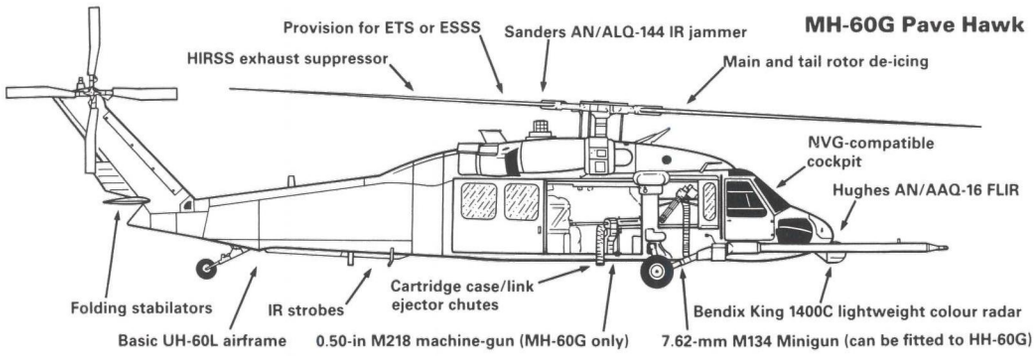
For service in Alaska this HH-60G is equipped with skis on all three of its undercarriage units.



working in conjunction with Motorola AN/PRC-112 survival radios. Finally, Phase Two upgrade provides for the installation of a Sanders AN/ALQ-144 IR jammer, a Dalmo Victor AN/APR-39A(V)-1 threat warning system, and a Tracor AN/ALE-40 countermeasures dispenser system. Phase Two modifications have now been incorporated in all special operations MH-60Gs and are being incorporated in SAR HH-60Gs.

The next upgrade phase calls for the installation of **(1)** a Hughes AN/AAQ-16 FLIR in a turret beneath the nose; **(2)** an Mil-Std-1553B databus; **(3)** HUD projecting heading and altitude information on one of the lenses of the pilot's AN/PVS-6 night vision goggles; **(4)** ring laser gyros in place of currently-installed Doppler; **(5)** IR strobes for night air refuelling; and **(6)** two cockpit display units (CDUs). Funding for this upgrade has been more difficult to obtain and has led to differences between the MH-60Gs and HH-60Gs. Notably, the Air Force was unable to obtain funding for the FLIR installation in rescue HH-60Gs and is providing only for the cockpit and wiring modifications required for the eventual retrofit of HH-60Gs with FLIR and CDUs. The National Guard Bureau, however, hopes to be able to fund the full FLIR installation for ANG-assigned HH-60Gs. Differences between the special operations and combat SAR versions also include the use of 0.50-in M218 machine-guns on the MH-60Gs and that of 0.30-in M60D guns or 7.62-mm M134 Miniguns on the HH-60Gs.

The 55th SOS at Eglin AFB received its first MH-60Gs in December 1987 and all of its UH-60A Credible Hawks have been



Above: An HH-60G pilot checks the jungle penetrator fitted to his aircraft's winch.

Left: This is the business end of an HH-60G, with colour weather radar to port and refuelling probe to starboard.

Below: A 7.62-mm M60 machine-gun (or a Minigun) can be mounted in the sliding windows of the HH-60G, as shown here.

Below: Combat rescue HH-60Gs serve with 11 training and rescue squadrons, including three ANG units. This aircraft serves with the California ANG at Moffett Field.

Sikorsky MH-60G Pave Hawk

The USAF's Black Hawk fleet includes two squadrons of special operations MH-60Gs, the 55th SOS at Hurlburt and the 71st SOS, an AFRES unit at Davis-Monthan. For Operation Desert Storm the 55th Special Operations Squadron was detached from its parent unit, the Hurlburt-based 1st Special Operations Wing, to Al Jouf in Saudi Arabia. The aircraft wears a rapidly-applied two-tone desert camouflage scheme, with three white recognition stripes around the tailboom.

Radar
The MH-60G has only a limited all-weather capability, by comparison with the larger MH-53J Pave Low III which equips other special operations squadrons. Lacking terrain-following radar, the MH-60G avoids adverse weather by using its Bendix-King 1400C colour weather radar. The use of NVGs and the Hughes AN/AAQ-16 FLIR (presently being fitted) give a measure of clear-weather night capability, but blind flying close to the ground is impossible, a major handicap in the Special Forces insertion role, which involves a great deal of night/adverse weather operation. The original air force Hawk, the HH-60D, was to have incorporated terrain-following radar, but this fell victim to budgetary constraints. Interestingly, the Army's Special Forces Black Hawk, the MH-60K, does feature such equipment.

The USAF and the H-60
The USAF's first Black Hawks were a batch of 11 UH-60As, one of which was converted to serve as the prototype of the very advanced HH-60D. Cutbacks forced the USAF to abandon the HH-60D, and the less ambitious HH-60A which was designed as its replacement. These variants were replaced by the MH-60G, which represented an austere, minimum-change version of the Army's basic Black Hawk.

Inflight-refuelling probe
The MH-60G and HH-60G are equipped with a semi-retractable inflight-refuelling probe to allow them to refuel from Hercules tankers.

HIRSS
MH-60Gs produced by the conversion of the original USAF UH-60As sometimes lack HIRSS, though this is slowly being retrofitted. Newer H-60Gs receive these on the production line, being delivered to Sikorsky Support Services in virtual UH-60L configuration.

Special Forces and 'Rescue Hawks'
Until the installation of the AN/AAQ-16 FLIR, the MH-60G and HH-60G were to all intents and purposes identical aircraft, the HH-60G designation being applied to aircraft assigned to the rescue role from October 1991, before which they were also known as MH-60Gs. In fact, most of the remaining Special Forces MH-60Gs are aircraft converted from the original batches of USAF UH-60As, although the 71st SOS is believed to be equipping with new aircraft.

Armament
This MH-60G is fitted with door-mounted 0.50-in machine-guns, and 7.62-mm Miniguns on pintle mounts in the sliding forward cabin windows. These have long tubular chutes fitted, allowing spent cases and ammunition links to be safely jettisoned. Since the MH-60G can be fitted with ESSS pylons, gun pods, rocket pods or ATGMs can also be carried.

brought up to Pave Hawk standards. Additional MH-60Gs have been procured for the 71st SOS (AFRES) at Davis-Monthan AFB, Arizona. Combat SAR-configured HH-60Gs, which entered service with the 210th Air Rescue Squadron, Alaska ANG, in July 1990, equip (or will soon equip) the following units: PACAF – the 38th Rescue Squadron at Osan AB, Korea, and a rescue squadron at Misawa AB, Japan; AMC – the 41st RQS at Patrick AFB, Florida, the 48th RQS at Holloman AFB, New Mexico, the 66th RQS at Nellis AFB, Nevada, and the 1551st Training Squadron at Kirtland AFB, New Mexico; AFRES – the 301st RQS at Homestead AFB, Florida, and the 304th RQS at the Portland IAP, Oregon; ANG – the 102nd RQS, NY ANG, at the Suffolk County AP, New York, the 129th RQS, CA ANG, at NAS Moffett Field, California, and the 210th RQS, AK ANG, at Kulis ANGS, Alaska.

Serials: MH-60Gs converted from UH-60As: 81-23643/81-23647, 82-23671, 82-23680, 82-23689, 82-23708, 82-23728, and 87-26006/87-26014. New-build HH/MH-60Gs: 88-26105/88-26120, 90-26222/90-26238, and others.

Special Operations Command operates two squadrons of MH-60Gs at Eglin and Davis-Monthan. This aircraft (which lacks HIRSS) belongs to the 55th SOS at Eglin's Hurlburt Field. Eventually, it will be possible to differentiate between HH- and MH-60Gs by the presence of an undernose FLIR turret.

Left: This 1st SOW MH-60G wears desert camouflage and white Desert Storm recognition stripes. The type saw active service during the Gulf War.

Above: The FLIR being fitted to the MH-60G is housed in a compact turret on the nose, between the radome and the refuelling probe.

Naval Variants

Seeking to extend the range at which its surface vessels could engage enemy submarines, the US Navy first explored during the second half of the 1950s the feasibility of embarking ASW torpedo-carrying helicopter drones aboard destroyers. This approach eventually resulted in Gyrodyne QH-50Cs becoming operational aboard the USS *Buck* (DD 761) in January 1963 but these drones were found to be difficult to operate from ships at night or under adverse weather conditions and did nothing to improve detection range as they were incapable of carrying the required sensors. As Soviet submarines were increasingly difficult to detect and were expected soon to be armed with surface-to-surface missiles, the USN adopted a two-prong approach calling for the installation of shipboard towed-array passive sonar for detection and classification of underwater contacts at great distance and out to the third convergence zone (i.e., beyond radio range), and the employment of shipborne manned helicopters to localise and prosecute submarines detected by surface vessels with their towed-array sonar and other systems.

Right: A Royal Australian Navy Seahawk in a low hover uses its dipping sonar to detect an enemy submarine.

LAMPS

As an interim solution to fill the Light Airborne Multi-Purpose System (LAMPS) requirement, the Navy elected in October 1970 to have some of its Kaman Seasprites modified to provide an over-the-horizon search and strike capability to ASW destroyers and frigates. The first of these SH-2Ds flew on 16 March 1971 and 20 were procured to equip Helicopter Combat Squadrons Four and Five (HC-4 and HC-5, later redesignated Light Helicopter Anti-Submarine (HSL) Squadrons 30 and 31). The first SH-2D deployment was made in December 1971 aboard the USS *Belknap* (CG 26) guided missile cruiser. The modification proved successful and subsequently 16 of the SH-2Ds and 84 earlier Seasprites were brought up to SH-2F standards with uprated T58-GE-8F engines, a crew of three (including a sensor operator), a Canadian Marconi LN-66HP search radar, a Texas Instrument AN/ASQ-81 towed magnetic anomaly detector (MAD) on the starboard side, and a 15-tube launch system for SSQ-41 passive or SSQ-47 active sonobuoys on the port side. During the 1980s, 54 new-build SH-2Fs and six SH-2Gs with T700-GE-401 engines were procured and 115 SH-2Fs were re-engined with T700s as SH-2Gs.

While LAMPS Mk I Seasprites filled the interim need and proved well-suited for operations from older surface vessels which could only accommodate one helicopter in their existing hangar, the Navy realised the need for a larger, more potent LAMPS to operate from the new 'Ticonderoga'-class Aegis guided missile cruisers, 'Spruance'-class destroyers, 'Kidd'-class guided missile destroyers, and 'Oliver Hazard Perry'-class guided missile frigates. The resultant LAMPS Mk III was intended as the detection/prosecution system associated with the SQR-109 towed array. As the array was going to be able to detect targets beyond the third convergence, the helicopter was to be given an independent prosecution capability. It was also to be fitted for anti-ship surveillance and targeting, and secondary missions were to include search and rescue, vertical replenishment, medical evacuation, fleet support and communications relay. Moreover, it was to be capable of all-weather operations and of recovery aboard ship in sea state five conditions (i.e., 28° roll, 5° pitch, and 15 ft per second heave).

While the Navy funded research and development of the required avionics for installation aboard surface vessels and helicopters, Navair concluded in late 1974 that the LAMPS Mk III helicopter would have to be larger than the Kaman Seasprite to accommodate the avionics and on-board operators but needed to be smaller than the Sikorsky Sea King so that two could fit in the hangar of small combatants (thus providing much-needed redundancy). Accordingly, in late 1974, just as the UTTAS contenders were entering flight trials, the Navy invited Boeing and Sikorsky to propose developments of their new helicopters as LAMPS Mk III platforms. Engines for LAMPS Mk III helicopters were to be either a navalised variant of the General Electric T700 turboshaft powering the UTTAS competitors or the 2,050-shp (1508-kW) Avco Lycoming T405-LD-400 turboshaft. Even though the Navy obtained a special dispensation from the Department of Defense allowing it not to be bound by the Army's selection, it was to be expected that the winner of the UTTAS competition would be the odds-on favourite to fill LAMPS Mk III requirements.

Both airframe manufacturers made determined efforts to win the Navy competition and modified the mock-up of their S-70 and Model 179 UTTAS entries to demonstrate that their S-70L (L for LAMPS, later changed to S-70B when the Army's variant of the Sikorsky was given the S-70A company designation while its proposed civil variant became the S-70C) and Model 237 would accommodate the 2,000-lb (907-kg) LAMPS Mk III mission avionics package. The navalised mock-ups were used to demonstrate ship compatibility, the Sikorsky S-70L mock-up going aboard the USS *Oliver Hazard Perry* (FFG 7) and *Arthur W. Radford* (DD 968) while the Boeing Model 237 mock-up went aboard the USS *Paul* (FF 1080).

To adapt its design to operations aboard ships and to enable it to be powered by more powerful engines in order to operate at higher weights, Sikorsky developed the following principal modifications for the S-70L: **(1)** beefed-up transmission; **(2)** electric power folding and brake for the main rotor; **(3)** single tail wheel replaced by a dual-wheel gear located further forward beneath the fuselage to fit on small decks; **(4)** simpler main gear with multi-disc brakes; **(5)** anti-corrosion finish and other changes dictated by extended operations in a salt-water environment; **(6)** structural provision for a deck landing harpoon system; **(7)** increased fuel capacity (from 360 to 590 US gal – 1,361 to 2,233 litres) and installation of a hover-in-flight refuelling system (HIFRS); **(8)** use of an advanced AFCS (automatic flight control system) with auto approach to a 40-ft hover and altitude hold; **(9)** elimination of the port sliding fuselage door and reduction in size of the starboard door, to provide room for some of the mission avionics, a forward-facing sensor operator station behind the co-pilot/airborne tactical officer seat on the port side, and installation of a 25-tube sonobuoy launch rack; **(10)** provision for a rescue hoist mounted externally above the starboard cabin door; **(11)** folding tailplane; **(12)** addition of a powerful environmental control system to heat, cool and dehumidify the cockpit and cabin – a critical requirement to ensure reliable avionic/electronic operation; and **(13)** addition of an emergency flotation system to keep the aircraft afloat long enough to allow the crew to escape.

Notwithstanding these changes, the naval version of the H-60 was to retain 83 per cent airframe and powerplant installation commonality with the basic Army UH-60A. Internal cabin arrangement, which kept evolving during the proposal phase of the project as avionics contractors were working with the Navy to develop the LAMPS Mk III mission package, was finalised only after IBM's Federal Systems Division, the systems prime contractor, completed its development work.

In July 1976, while Boeing and Sikorsky were finalising their proposal, the first land-based test designed to evaluate the latest weapons systems for future LAMPS Mk III were performed at Patuxent River by one of the two specially-modified Sikorsky YSH-3Js. This was followed by ship-based tests aboard the USS *Mount Baker* (AE 34) during September and October 1976. During that same time, the Navy evaluated American, British, Canadian and French helicopter recovery devices, as intended operations under sea state five conditions made essential the development of a reliable system to provide helicopter guidance to landing, security while on a pitching deck, and movement between the hangar and the flight deck. None of the existing foreign systems nor a specially developed American device was found satisfactory. The requirement was finally met by Dominion Aluminium Fabrication (DAF) Indal Ltd with its RAST (recovery assist secure and traverse) gear, a development of the Canadian 'Beartrap' helicopter haul-down and rapid securing device (HHRSD).

The SH-60 mock-up actually went to sea aboard the USS* Oliver Hazard Perry *and the USS* Arthur W. Radford *for shipboard compatibility trials, even receiving squadron markings eventually.

Although Boeing had finally been able, in November 1976, to eliminate the vibration problem which had plagued the development of its Model 179, the announcement on 23 December 1976 that the Army had selected Sikorsky as the winner of the UTTAS competition all but made it probable that the S-70L would be selected by the Navy as the platform for the airborne components of the LAMPS Mk III. Likewise, costs and commonality considerations made it just as probable that General Electric would get the engine contract. Indeed, after final selection was delayed six months past the original March 1977 schedule, the Navy announced on 1 September 1977 its selection of Sikorsky as air vehicle contractor, General Electric as engine contractor, and DAF Indal Ltd as shipboard recovery system contractor. More significantly, IBM's Federal Systems Division at Owego, NY, was confirmed as systems prime contractor with responsibility for integration and total performance of the entire ship/air system. At that time, the airframe, engine and systems contractors were awarded engineering contracts amounting respectively to $2.7 million, $547,000, and $17.9 million. This arrangement was confirmed on 28 February 1978 when the Department of Defense authorised full-scale development of the SH-60B LAMPS Mk III.

As detailed more fully under the YSH-60B heading, the first prototype flew on 12 December 1979. Successful evaluation of the full-scale development aircraft led to an initial contract for 18 SH-60Bs being awarded during FY82. Since then, the SH-60B has been continually upgraded to meet evolving USN requirements. In addition, as detailed under the appropriate headings, the Navy has procured SH-60Bs for Spain, SH-60Fs for service aboard carriers, HH-60Hs for combat rescue operations and HH-60Js for the Coast Guard. US and foreign naval versions of the H-60/S-70 have been given the following company's S-70B and S-70C designations: S-70B-1 – SH-60B for USN and Spain; S-70B-2 – SH-60B derivative for Australia; S-70B-3 – YSH-60J for Japan; S-70B-4 – SH-60F for US Marine Corps; S-70B-5 – HH-60H for USN and HH-60J for US Coast Guard; S-70B-6 – SH-60B/SH-60F hybrid for Greece; and S-70C(M)-1–SH-60B for Taiwan.

YSH-60B Seahawk

On 28 February 1978, six months after its S-70L had been selected as the helicopter for the LAMPS Mk III, Sikorsky was awarded a $109.3-million contract for five full-scale development YSH-60Bs (BuNos 161169/161173) and a ground test vehicle. In a pattern which was to be repeated during the course of production, the YSH-60Bs were to be completed by Sikorsky in a rather bare configuration prior to being flown to Owego, where IBM was to install the mission avionics (details of which are included in the SH-60B entry). Accordingly, when it was completed in August 1979 and first flown on 12 December 1979, BuNo. 161169 had empty fairings on the chins and on each side of the rear fuselage (for the ESM antennas which were to be installed by IBM), centrally beneath the nose and the tail boom (for the datalink antennas), and beneath the forward fuselage (for the search radar antenna). It also had a stores pylon on each side of the fuselage, that on the port side being located slightly more forward, and a pylon on the starboard side of the boom for the towed MAD bird. Power was provided by two General Electric T700-GE-701 turboshafts with maximum continuous rating of 1260 kW (1,690 shp) and maximum emergency rating of 1285 kW (1,723 shp). In addition to their higher ratings, the T700-GE-701s differed from the T700-GE-700s powering the Army's UH-60As in incorporating improved corrosion protection.

With the four other YSH-60Bs joining the trial programme between February and July 1980, progress was rapid. Key dates in the early development phases were 2 April 1980, when the second YSH-60B arrived at the NATC at Patuxent River to begin electromagnetic vulnerability testing prior to delivery to IBM in Owego; 28 May 1980, when a YSH-60B fully equipped with mission avionics was sent on a simulated ASW mission from the IBM test site at Owego; and 6 January 1981, when the RAST was first used during tests aboard the USS *McInerney* (FFG 8).

Operational test and evaluation (OT&E) was initiated in May 1981 after Air Test and Evaluation Squadron One (VX-1) at NAS Patuxent River, Maryland, had received two YSH-60Bs. OT&E aboard the *McInerney* began on 13 May 1981 and at the conclusion of this first evaluation phase, Commander Operational Test and Evaluation Force forwarded a favourable recommendation regarding initial LAMPS Mk III procurement. On COMOPTEVFOR recommendation, an initial contract for 18 Lot 1 SH-60Bs (BuNos 161553/161570) was awarded at the beginning of FY82 while VX-1 conducted full weapons systems operational evaluation between October 1981 and January 1982. Bureau of Inspection and Survey trials were completed by 1 September 1982, by which time the five FSD Seahawks had accumulated more than 3,000 flight hours.

BuNos: 161169/161173.

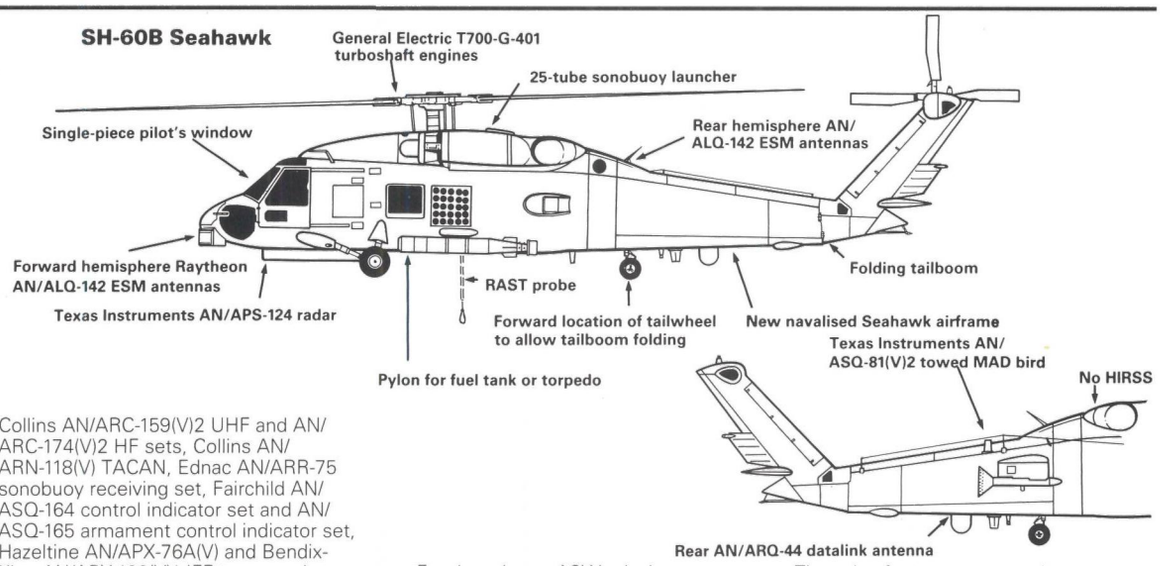
Left: The fourth of five YSH-60B prototypes, lacking the extended test instrumentation boom fitted to earlier prototypes. The aircraft carries the legend 'Seahawk for LAMPS'.

Right: The first prototype YSH-60B in flight clearly shows the 25-shot sonobuoy launcher on the port side of the fuselage.

The first prototype YSH-60B had a long test instrumentation boom, mounted directly onto the right-hand side of the undernose radome.

SH-60B Seahawk

Airborne component of the LAMPS Mk III system, SH-60Bs (the first of which, BuNo. 161533, flew for the first time on 11 February 1983) integrate the tactical capabilities of a surface combatant ship and a helicopter for the ASW and anti-ship surveillance and targeting missions. To do so, Seahawks are fitted with state-of-the-art avionics. In the case of initial production Seahawks, Lots 1 to 8, this includes a Texas Instrument AN/APS-124 search radar under the forward fuselage, a Sikorsky 25-tube sonobuoy launcher on the starboard side of the cabin (each tube housing five SSQ-53 DIFAR (directional low-frequency analysis and recording) or SSQ-60 DICASS (directional command-activated active) sonobuoys, a Texas Instruments AN/ASQ-81(V)2 towed MAD bird, an IBM AN/UYS-1(V)2 Proteus acoustic processor, a Control Data AN/AYK-14 digital computer, Raytheon AN/ALQ-142 passive ESM equipment in four chin and rear fuselage housings, and Sierra Research AN/ARQ-44 datalink and telemetry equipment in a housing beneath the nose and in a fairing beneath the tail boom. Principal other SH-60B mission and navigation avionics include Astronautics IO-2177/ASQ altitude indicator, Collins AN/ARA-50 UHF DF, Collins AN/ARC-159(V)2 UHF and AN/ARC-174(V)2 HF sets, Collins AN/ARN-118(V) TACAN, Ednac AN/ARR-75 sonobuoy receiving set, Fairchild AN/ASQ-164 control indicator set and AN/ASQ-165 armament control indicator set, Hazeltine AN/APX-76A(V) and Bendix-King AN/APX-100(V)1 IFF transponders, Honeywell AN/APN-194(V) radar altimeter, Raymond MU-760/ASQ magnetic tape memory unit, Teledyne Ryan AN/APN-217 Doppler, Telephonics OK-374/ASC communications system control group, TSEC/KG-45(E-1) communications security set, and TSEC/KY-75 voice security set.


SH-60B Seahawk
General Electric T700-G-401 turboshaft engines
25-tube sonobuoy launcher
Single-piece pilot's window
Rear hemisphere AN/ALQ-142 ESM antennas
Forward hemisphere Raytheon AN/ALQ-142 ESM antennas
Texas Instruments AN/APS-124 radar
RAST probe
Folding tailboom
Forward location of tailwheel to allow tailboom folding
New navalised Seahawk airframe
Texas Instruments AN/ASQ-81(V)2 towed MAD bird
Pylon for fuel tank or torpedo
No HIRSS
Rear AN/ARQ-44 datalink antenna

For the primary ASW mission, armament of initial production SH-60Bs consists of two Mk 46 lightweight torpedoes. For the secondary SAR mission a rescue hoist/winch is mounted on the starboard side above the cabin door. Power for initial production SH-60Bs is provided by two 1260-kW (1,690-shp) T700-GE-401 turboshafts. They also feature an uprated transmission, a rotor brake and electrically-folded main rotor blades. Internal fuel capacity in two fuselage fuel cells is increased from 360 US gal (1,361 litres) for the UH-60A to 590 US gal (2,233 litres); two 120-US gal (455-litre) auxiliary tanks can be carried on fuselage pylons in place of the torpedoes. A hover

Sikorsky SH-60B Seahawk

This SH-60B wears the 'TZ' tailcode of North Island-based HSL-45 'Wolfpack'. No other unit identification is carried on the toned-down colour scheme. HSL-45 was established on 3 October 1986 to operate the SH-60B LAMPS III aboard ships of the Pacific Fleet. At least one detatchment from HSL-45 was deployed to the Gulf during Operation Desert Storm, flying from FFG-33, the USS *Jarrett*.

Sonobuoys
One of the most reliable and accurate methods of detecting a submarine is by laying down a pattern of directional sonobuoys. The SH-60B can carry a mixture of passive and active buoys. Such sonobuoys are pneumatically launched from 25 tubes which exit on the port side of the cabin. Four reloads can be carried for each tube.

Search radar
Although radar is of no use in detecting submerged targets, it is useful for detecting surface vessels or even submarine snorts or periscopes. The SH-60B is fitted with a Texas Instruments AN/APS-124 radar under the nose. One Seahawk has already flown with an AN/APS-137(H) inverse synthetic aperture radar, which will give an 'over-the-horizon' targeting capability.

Modifications
In recent years, SH-60Bs have been equipped with new radar warning receivers, missile approach warning systems, and chaff/flare dispensers and IR jammers to allow them to operate in today's high-threat environment.

LAMPS
The role of the SH-60B is to act as a LAMPS (Light Airborne Multi-Purpose System) aboard US Navy frigates and destroyers. The helicopter performs utility, medevac, rescue and VertRep duties but is primarily configured for the ASW role, with a search radar, ESM, active and passive sonobuoys and a towed MAD sensor.

MAD
The Texas Instruments AN/ASQ-81(V)2 Magnetic Anomaly Detector uses a towed 'bird' to detect submarines by measuring disturbances in the earth's magnetic field which are caused by the presence of a large metallic object. The 'bird' has to be towed well behind the helicopter.

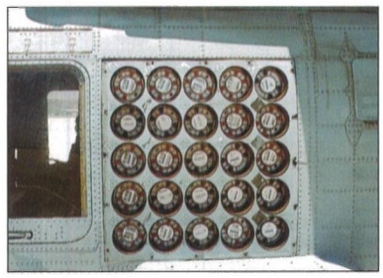
Deployment
The SH-60B community consists of 10 squadrons, with one training unit and four deployable squadrons each at NAS Mayport in Florida and at NAS North Island, California. An 11th squadron is based at Atsugi, Japan. They are backed up by eight regular and three Reserve SH-2F/SH-2G squadrons, which serve primarily aboard the smaller 'Knox'-class frigates and 'Kidd'-class destroyers. SH-60 squadrons deploy one or two aircraft detachments aboard the US Navy's 'Spruance'-class destroyers, all but the first two 'Ticonderoga'-class Aegis cruisers, and the second and 25th to 51st 'Oliver Hazard Perry'-class frigates.

Weapons
Although this SH-60B is shown unarmed, the aircraft can carry a pair of torpedoes, or Penguin anti-ship missiles, on the stub pylons aft of the cabin door and at the same point on the starboard side.

Rotor
The four-bladed main rotor has hollow tubular titanium spars, with graphite roots and trailing edges, Nomex honeycomb cores and a glassfibre epoxy covering. The individual blades fold electrically. The tail rotor is canted upwards by 20° giving an extra lift component, as well as countering the torque of the main rotor.

Today most SH-60Bs have sprouted 'flowerpot' like fairings which serve as mountings for the forward hemisphere electronic support measures (ESM) antennas. Just the mounting is shown here.

For detecting submarines the SH-60B can use its AN/ASQ81(V)2 towed Magnetic Anomoly Detector, which senses disruptions in the earth's magnetic field caused by the presence of any large metal object.



The SH-60B carries a 25-tube Sikorsky sonobuoy launcher, each tube housing SSQ 53 or SSQ 60 directional passive or active sonobuoys. Many current SH-60Bs seem to have this launcher faired over.

The sonobuoy launcher takes up a large amount of space inside the SH-60B's cabin. Separate pipes snaking out from the centre point serve the pneumatic ejection system, and allow the sonobuoys to be launched in sequence.

inflight refuelling (HIFR) system is provided to enable the SH-60B to be refuelled without having to land on a ship.

The SH-60B crew consists of a pilot, an airborne tactical officer (ATO) who also acts as assistant pilot, and a sensor operator (SO). During the execution of a mission, the Seahawk's sensors are controlled via two-way datalink from the ship's Combat Information Center (CIC) by an acoustic sensor operator (ASO), a remote radar operator (REMRO), an electronic warfare operator (EWO) and the air tactical control officer (ATCO). Airborne crew members co-ordinate activities and are prepared to assume full control when required by the tactical situation. Final localisation and attack, which typically take place below the communications horizon, are performed independently by the SH-60B crew using MAD and torpedoes.

Following entry into service, development of the Seahawk has continued and an SH-60B fitted by Sikorsky with 1566-kW (2,100-shp) Rolls-Royce/Turboméca RTM 322s first flew at West Palm Beach, Florida, on 3 April 1987 to take part in an 80-hour test programme aimed at clearing the European powerplant for possible installation in late production SH-60Bs. The RTM 322, for which Pratt & Whitney acquired manufacturing rights from Rolls-Royce/Turboméca in November 1986, competed against the 1447-kW (1,940-shp) T700-GE-401C, a pair of which was installed in a modified SH-60B which flew 45.8 hours between 13 and 30 September 1987. In the end, the Navy selected the T700-GE-401C to power late production SH-60Bs as well as SH-60Fs and HH-60Hs. Initially, rather than ordering additional T700-GE-401Cs to re-engine early production SH-60Bs, the Navy ordered these engines as part of its procurement of Kaman SH-2Gs for the improved LAMPS Mk I role and Bell AH-1Ws for the Marine Corps. As both SH-2Gs and AH-1Ws have adequate performance on the power of T700-GE-401s, the -401Cs are being swapped for -401 engines powering early production SH-60Bs, with the Seahawks receiving the more powerful engines. Seahawks powered by -401C engines were delivered beginning in April 1988.

During the spring of 1991, a modified SH-60B of HSL-46 was fitted with a GEC Sea Owl passive detection system in a turret on the lower starboard side of the centre fuselage. Sea Owl provides a high-resolution infra-red system for target detection, identification and tracking, but a decision regarding possible retrofit of the Sea Owl system to fleet SH-60Bs is still pending.

MEF-MOD Package: During 1987, as a result of the continued war between Iraq and Iran and the resulting threat to freedom of navigation in the Persian Gulf, helicopters began to play a heavy role in this theatre of operations as part of Operation Earnest Will. With the US Navy providing escort for US-flagged tankers plying Persian Gulf waters, the need for SH-60Bs to assist in spotting mines, fast motorboats and shore-launched Silkworm missiles led to the rapid implementation of the MEF-MOD (Middle East Force-Modification) programme. In a matter of weeks, Sikorsky technicians modified Seahawks for Earnest Will deployments (the first modified SH-60Bs leaving CONUS on 6 July 1987). As part of this programme, 25 SH-60Bs were fitted with **(1)** Sanders AN/ALQ-144 infra-red jammers above and below the fuselage to protect against Stinger or Strela missiles (the fitting of HIRSS was considered but rejected as it would have entailed a more expensive and time-consuming strengthening of engine covers); **(2)** Tracor AN/ALE-39 chaff/flare dispensers on the tail boom to protect the helicopters from heat-seeking missiles and ships from radar-guided Silkworm missiles; **(3)** Honeywell AN/AAR-47 electro-optical missile warning sets to spot Stinger or Silkworm plumes; **(4)** a door-mounted 7.62-mm M60D machine-gun to detonate mines or suppress fire from gunboats; **(5)** Collins AN/ARC-182 UHF/VHF/FM radio; and **(6)** a Texas Instruments AN/TAS-6A thermal imager hung from a bungee cord in the aft cabin and Stabiliscope binoculars to identify contacts in limited visibility. Seven of the MEF-MOD SH-60Bs were further modified by mounting a Ford Aerospace AN/AAS-38 FLIR pod on their port side store station.

Right: Unloading sonobuoys from an unmarked SH-60B at Patrick AFB, during temporary detachment from NAS Jacksonville. The aircraft in the background is an SH-60F from HS3.

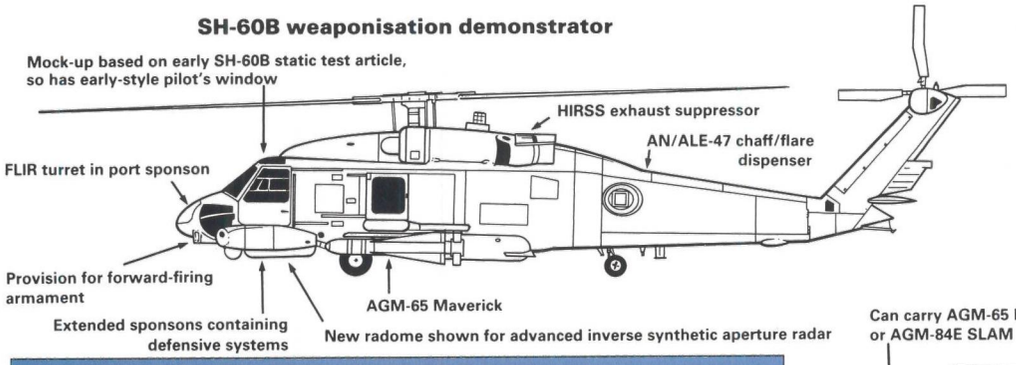
Below: An SH-60B of HSL-42 taxis out at Mayport. Squadron markings are rarely carried by the SH-60B, with the red and yellow MAD bird often providing the only splash of colour.

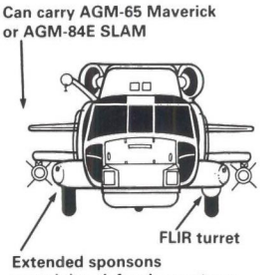
Altogether these modifications increased the SH-60B's weight by 370 lb (168 kg) but proved highly successful during operations in the Persian Gulf in 1987-88. Furthermore, they provided a basis for later upgrades of the Navy's Seahawks.

Block I Upgrade: Beginning with production Lot 9 in 1989, and through the planned retrofit of 115 earlier Seahawks, SH-60Bs have had their versatility and capability increased by the inclusion of provision for Honeywell Mk 50 Barracuda lightweight torpedoes, which are faster and deeper diving than Mk 46 torpedoes and have a Honeywell active/passive acoustic seeker capable of detecting targets faster and at greater range, and the addition of an AGM-119B Penguin Mk 2 Mod 7 anti-shipping missile developed in Norway by Kongsberg Vaapenfabrikk/ Norsk Forsvasteknologi AS and modified by Grumman to have folding fins. Initial operational capability with the AGM-119B is planned for early 1993. Lot 9 SH-60Bs and modified Seahawks have three external stores stations, one inboard on each side for torpedoes, AGM-119B missiles or auxiliary tanks, and one outboard on the port side for an auxiliary tank. Other Block I upgrades include the addition of two dual-channel 1553B buses, a Collins AN/ARC-182 UHF/ VHF/FM radio, Rockwell/Collins Class 3A Navstar global positioning system, a Rospatch AN/ARR-84 99-channel sonobuoy receiver (in place of the Ednac AN/ARR-75 receiver fitted to earlier SH-60Bs), and provision for pintle-mounted GECAL 50 machine-guns.

Block II Upgrade: Based on Earnest Will and Gulf War experience, other Seahawk upgrades currently under consideration, but not yet funded, include the Block II near-term improvement package adding **(1)** an inverse synthetic aperture radar to allow the SH-60B to classify over-the-horizon targets (a prototype of the Texas Instrument AN/ APS-137(H) has already been fitted to a West Coast SH-60B); **(2)** two additional colour displays; **(3)** a Hughes/Thomson-CSF advanced dipping airborne low-frequency sonar with a detection area 16 times greater than current USN sonar systems; **(4)** a new sonobuoy launching system with the pneumatic launcher on the port fuselage side replaced by a gravity system beneath the fuselage; **(5)** lengthened sponsons; **(6)** a radar warning receiver; **(7)** a missile warning system; **(8)** a countermeasures dispensing system; **(9)** Sanders AN/ ALQ-144 IR jammers; and an FLIR or Hughes AESOP (Airborne Electro-Optical Special Operations Payload) laser-augmented FLIR. To operate these systems, two additional operators would be required and gross weight would increase from 21,884 lb (9926 kg) to around 24,000 lb (10880 kg). Other improvements currently under consideration include an acoustic intercept system capable of detecting a number of specific submarine characteristics from sonobuoy and sonar data, a coupled flight director, digital map and colour displays, a foldable sponson extension to provide a fourth store station with a 1,200-lb (544-kg) capacity, and additional weapons capability (including Maverick, Hellfire, Sidearm or Sidewinder missiles). Sikorsky is also proposing to integrate the McDonnell Douglas Stand-off Land Attack Missile (SLAM) to increase further the SH-60B versatility. With SLAM, SH-60Bs will be able to hit targets at ranges of up to 100 nm (115 miles; 185 km), or 200 nm

SH-60B weaponisation demonstrator


Mock-up based on early SH-60B static test article, so has early-style pilot's window
HIRSS exhaust suppressor
AN/ALE-47 chaff/flare dispenser
FLIR turret in port sponson
Provision for forward-firing armament
Extended sponsons containing defensive systems
AGM-65 Maverick
New radome shown for advanced inverse synthetic aperture radar



The appearance of most surviving SH-60Bs will be transformed by the planned upgrades, which will add weapons stations and antennas for much new equipment.

(230 miles; 370 km) if fold-out wings are added to the missiles. Alternatively, as currently under evaluation at the Naval Air Warfare Center Weapons Division (renamed in January 1992 from Pacific Missile Test Center) at Point Mugu, California, the SH-60B could be adapted to provide terminal guidance for SLAMs launched by fixed-wing aircraft. With the added weight and drag resulting from the incorporation of Block II Upgrades, more powerful engines are likely to be required.

Service history: USN requirements were initially given at 204 SH-60Bs but have since been increased to 260, of which 156 had been delivered by mid-June 1992. Whether all 260 will be built remains in doubt now that the national defence budget is being slashed.

Two YSH-60Bs were delivered to the West Coast fleet replacement squadron HSL-41 at NAS North Island, California, in January 1983 to enable training to commence before completion of the first production SH-60B. Thereafter, SH-60Bs were delivered to five light helicopter anti-submarine squadrons in the Atlantic Fleet: HSL-40 'Airwolves' (tailcode 'HK'), HSL-42 'Proud Warriors' ('HN'), HSL-44 'Swamp Foxes' ('HP'), HSL-46 'Grandmasters' ('HQ'), and HSL-48 'Vipers' ('HR') all home-ported at NAS Mayport, Florida; and to five HSLs in the Pacific Fleet: HSL-41 'Seahawks' ('TS'), HSL-43 'Battlecats' ('TT'), HSL-45 'Wolfpack' ('TZ'), HSL-47 'Saberhawks' ('TY'), and HSL-49 'Scorpions' ('TX') all home-ported at NAS North Island, California, and to HSL-51 'Warlords' ('TA') home-ported at Yokosuka, Japan. In addition, SH-60Bs went to the Rotary Wing Aircraft Test Directorate, Naval Air Test Center (now NAWC Aircraft Division), and VX-1, both based at NAS Patuxent River, Maryland.

SH-60Bs first deployed when an HSL-43 detachment went aboard the USS *Crommelin* (FFG 37) on 21 February 1985, barely two months after the 'Battlecats' had received their first two operational Seahawks. Since then, Seahawks have taken part in Operation Earnest Will in the Persian Gulf during the period of confrontation with Iran, and in the war to liberate Kuwait. All eight deployable squadrons (HSL-42, -43, -44, -45, -46, -47, -48 and -49) sent detachments during Desert Shield/Desert Storm. In the Gulf, SH-60B detachments mainly flew boarding parties during the maritime blockade which preceded the war and went on to fly mine patrols, undertake strike rescue (the pilot of an F-16 being rescued on 24 January and that of an AV-8B on 25 February), and transport SEAL combat teams to Iraqi oil platforms and occupied Kuwait.

Foreign purchases include SH-60Bs procured for Spain by the US Navy, Australian S-70B-2s, Greek S-70B-6s, and Japanese S-70B-3s (YSH-60J/SH-60Js).

BuNos: 161553/161570, 162091/162139, 162326/162389, 162974/162997, 163038/ 163043, 163233/163258, 163593/163598, 163905/163910, 164174/164179, 164461/ 164466, 154808/164819, and 164847/ 164858.

In addition to its ASW role, the SH-60B has many other uses. These include transport of cargo and personnel, SAR anti-ship attack and missile warning and decoy work.

SH-60F Seahawk

(unofficially 'Ocean Hawk' or 'CV-Helo')

In 1985, with the SH-60B established into service, the Navy turned its attention to finding a 'CV-Helo' with which to replace its Sikorsky SH-3Gs and SH-3Hs serving in the inner zone ASW and plane-guard roles with helicopter anti-submarine squadrons deploying aboard aircraft-carriers. To meet this requirement, development of the S-70B-4 'Ocean Hawk' variant was initiated with the award to Sikorsky, on 6 March 1985, of a $50.9-million full-scale development contract, with production options, for a derivative of the SH-60B. Avionics integration was entrusted to Teledyne Systems Company. This SH-60F was to retain the SH-60B's navalised airframe and powerplant (1447-kW/1,940-shp T700-GE-401Cs being adopted for production SH-60Fs) but was to have the LAMPS Mk III avionics and RAST equipment replaced with systems optimised for the ASW role.

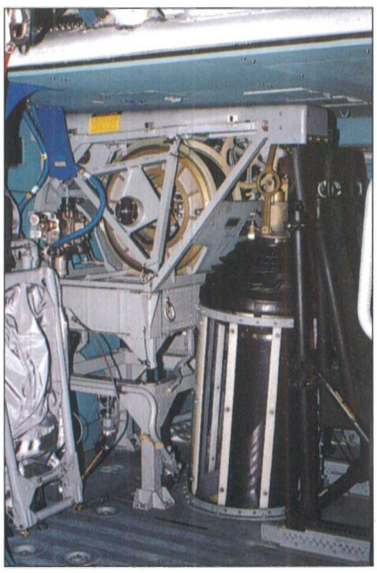
The SH-60F prototype (BuNo. 161170, which had been built and flown as the second YSH-60B) first flew at Stratford on 19 March 1987. OT&E began in June 1987, initial carrier evaluation took place aboard the USS *John F. Kennedy* (CV-67) and USS *Dwight D. Eisenhower* (CVN-69) in 1987-88, and follow-on test and evaluation was completed aboard the USS *America* (CV-66) in February 1989. A year and a half earlier, production had been initiated with the awards of an FY87 contract for seven pre-series SH-60Fs (BuNos 163282/163288). The US Navy has announced that it would require 175 SH-60Fs, of which 73 have been ordered and 54 delivered by mid-June 1992. Production is continuing but budget constraints may lead to procurement being curtailed short of the stated requirement, a likely occurrence if the number of deployable carriers, hence of air wings and their helicopter anti-submarine squadrons (HELANTI-SUBRONs), continues to be reduced.

On delivery, SH-60Fs were fitted with eight sonobuoys which are dropped manually through a tube in the main cabin, and a Bendix Oceanics AN/AQS-13F dipping sonar which can be lowered to a depth of 1,500 ft/455 m, more than three times the depth at which the sonar of the SH-3H can be lowered, thus markedly improving the Ocean Hawk's ability to locate submarines. They were equipped with integrated avionics system built around an Mil-Std-1553B databus, a Tactical Data Management System (TADS) with dual Teledyne AN/ASN-150 tactical navigation computers, a Teledyne TacNav 2 tactical datalink to other aircraft (i.e., carrier-based Lockheed S-3 Vikings and shore-based Lockheed P-3 Orions), and a modified AFCS adding automatic transition to both sonar cable and Doppler hovers. Provision was incorporated in the design for later installation, if funded, of night vision equipment, FLIR, Navstar GPS, surface search radar, MAD system, attitude and heading reference (AHRS), ECM equipment, and chaff/flare dispensers.

Intended to operate independently, as opposed to the SH-60Bs which remain under the control of the CIC aboard their parent ship, the SH-60Fs have a crew of four: pilot, airborne tactical officer/co-pilot, sonar operator, and sensor operator, each having a multi-function keypad and a central display unit on which to present navigation and tactical data. Fully configured for ASW with two Mk 46 or Mk 50 torpedoes and a 120-US gal/455-litre external tank, the SH-60F has a mission endurance of more than four hours. For shorter duration missions, the external tank can be replaced by a third torpedo. Secondary missions include plane-guard and search and rescue (for which the SH-60F is fitted with the same rescue hoist/winch as the SH-60B), medevac, anti-ship missile defence, and logistic support. Principal other SH-60F mission and navigation avionics include Astronautics IO-2177/ASQ altitude indicator, Collins AN/ARA-50 UHF DF, Collins AN/ARC-182 UHF/VHF/FM sets, Collins AN/ARN-118(V) TACAN, Ednac AN/ARR-75 sonobuoy receiving set, Fairchild AN/ASQ-164 control indicator set and AN/ASQ-165 armament control indicator set, Hazeltine AN/APX-76A(V) and Bendix-King AN/APX-100(V)1 IFF transponders, Honeywell AN/APN-194(V) radar altimeter, Raymond MU-760/ASQ magnetic tape memory unit, Teledyne Ryan AN/APN-217 Doppler, Telephonics OK-374/ASC communications system control group, TSEC/KG-45(E-1) communications security set, and TSEC/KY-75 voice security set.

This SH-60F is HS-3's CAG-bird, and as such shows a rare flash of colour, with its black and red squadron badge.

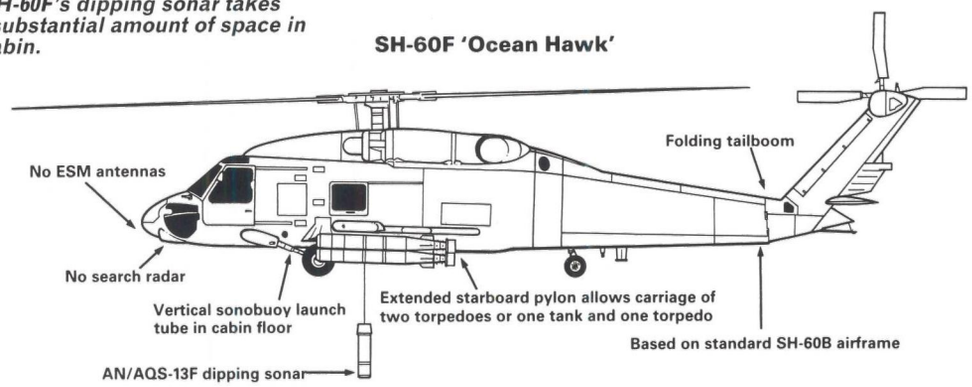
The first Ocean Hawks went to the West Coast FRS (HS-10 'Taskmasters' at NAS North Island, California) on 22 June 1989, the first training syllabus flight was made on 14 October 1989, and the squadron made its first rescue on 5 October 1989 when one of its SH-60Fs was diverted from a training flight to retrieve two naval aviators off the coast of southern California. The first SH-60F deployable squadron, HS-2 'Golden Falcons' at NAS North Island, received Ocean Hawks in March 1990. Additional squadrons (including HS-6 'Indians', HS-4 'Black Knights', and HS-8 'Eight Ballers' all at NAS North Island, and HS-3 'Tridents' at NAS Jacksonville) transitioned in 1990 and 1991 but did so too late to take part in Desert Shield/Desert Storm. After the SH-60F entered service, the Navy decided that its helicopter anti-submarine squadrons would deploy with a mix of four SH-60Fs, for primary use in the inner zone ASW role, and two HH-60Hs for strike rescue



Above: From the port side, the SH-60F can be distinguished from the SH-60B by its lack of radar, ESM and MAD, and from the HH-60H by its lack of HIRSS.

Left: The winding mechanism for the SH-60F's dipping sonar takes up a substantial amount of space in the cabin.

SH-60F 'Ocean Hawk'


Folding tailboom
No ESM antennas
No search radar
Vertical sonobuoy launch tube in cabin floor
Extended starboard pylon allows carriage of two torpedoes or one tank and one torpedo
Based on standard SH-60B airframe
AN/AQS-13F dipping sonar

and plane-guard duty. The first such deployment was made by HS-2, as part of CVW-9 aboard the USS *Nimitz* (CVN 68), which left its home port for the Indian Ocean on 25 February 1991.

Currently planned 'Block I' improvements will provide a second Mil-Std-1553B databus, an AT&T AN/UYS-2 acoustic processor, a periscope detection radar, a two-way ship-to-aircraft datalink and an AN/APX-76 IFF, and will substitute a Hughes/Thomson-CSF Airborne Low-Frequency Sonar (ALFS) for the currently installed Bendix Oceanics AN/AQS-13F dipping sonar. (Bendix, which is protesting the selection of Hughes/Thomson-CSF, is offering its AN/AQS-13G as a more cost-effective alternative.) To improve survivability, SH-60Fs will be fitted with a General Instrument AN/APR-39A(XE)2 radar warning receiver, a Honeywell AN/AAR-37 infra-red-guided missile warning system, Sanders AN/ALQ-144 IR jammers, HIRSS infra-red suppressors to cool engine exhaust and reduce IR detectability, door-mounted GECAL 50 machine-guns, and forward-firing guns. Long-term updates similar to some of the SH-60B 'Block II' upgrades described under a preceding heading including the fitting of a Texas Instrument AN/APS-137(H) inverse synthetic aperture radar are also contemplated but funding is unlikely to be provided for several more years.

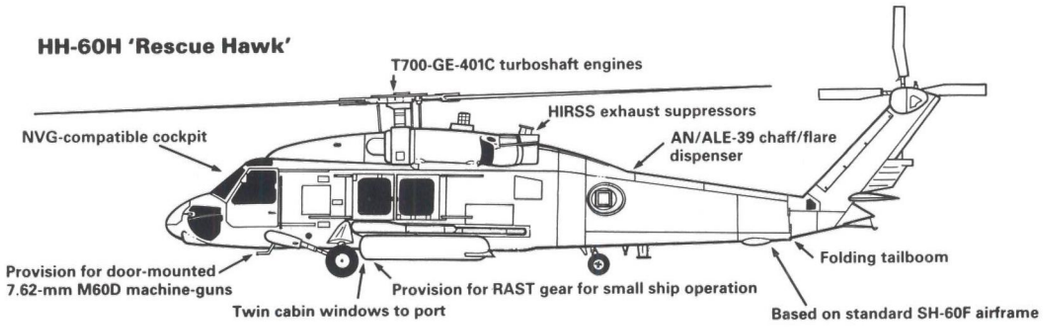
The Taiwanese S-70C(M)-1, which uses airframes similar to the SH-60F, is described separately.

Above: The SH-60F is designed for inner-zone ASW protection of the carrier battle group, using its sonar to detect enemy submarines which it may then engage or leave to other assets.

Right: The port stores station incorporates an extended stub 'wing' to allow the carriage of two torpedoes, or a tank and a torpedo.

BuNos: 163282/163288, 164069/164104, 164423/164440, 164443/164460, 164609/164620, and 164796/164807.

HH-60H Seahawk
(unofficially 'Rescue Hawk')


HH-60H 'Rescue Hawk'
T700-GE-401C turboshaft engines
HIRSS exhaust suppressors
NVG-compatible cockpit
AN/ALE-39 chaff/flare dispenser
Folding tailboom
Provision for door-mounted 7.62-mm M60D machine-guns
Provision for RAST gear for small ship operation
Twin cabin windows to port
Based on standard SH-60F airframe

In the mid-1980s, when its only dedicated combat rescue squadron was a reserve unit (HC-9 'Protectors' equipped with Sikorsky HH-3As), the Navy belatedly recognised the need to review its policy, training and tactics related to combat SAR and to order new equipment for that mission. One of the results of this policy review was a change from combat SAR, a reactive mission mounted when crews were downed, to strike rescue, a proactive mission which is an integral part of strike planning and execution. As success of strike rescue missions would depend in a large part on the availability of more capable helicopters, the Navy funded Sikorsky to study the S-70B-5, a variant closely derived from the SH-60F, which, with minimum changes, would meet its strike-rescue/special warfare support (HCS) requirement for a strike rescue helicopter and the medium-range recovery (MRR) requirement of the US Coast Guard. An initial contract for five HH-60Hs (BuNos 163783/163787) and two HH-60Js (BuNos 163801/163802, with corresponding USCG serials 6001/6002), respectively configured for the HCS and MRR missions, was awarded in September 1986. The first HH-60H 'Rescue Hawk' flew at Stratford on 17 August 1988.

The primary mission of the HH-60H is strike rescue, for which the principal design criterion was the ability of recovering a four-man crew – that of an S-3 or EA-6B – 250 nm (288 miles; 463 km) from its ship or base. Its secondary mission is special warfare operations, for which it was designed to 'infil/exfil' eight combat-equipped SEALs 200 nm (230 miles; 370 km) from its ship or base. The airframe and 1447-kW (1,940-shp) T700-GE-401C engines are essentially similar to those of the SH-60F but its avionics and equipment are adapted to its missions. They include a General Instrument AN/APR-39A(XE)2 radar warning receiver, Honeywell AN/AAR-47 missile plume detector, Hughes AN/AVR-2 laser warning receiver, Loral AN/ALE-47 chaff/flare dispensers, Sanders AN/ALQ-144 IR jammers, hover infra-red suppressor subsystem (HIRSS), and Cubic PRC-112/ARS-6 pilot locating system (PLS). For combat operations the HH-60H is armed with two door-mounted 7.62-mm M60Ds and its crew members wear T-65 body armour. Its cockpit is fitted out for NVG operations. Unlike the SH-60Fs, the HH-60Hs retain provision for the RAST equipment to enable them to operate from the same combatants as the SH-60Bs. However, not all HH-60Hs are normally equipped with RAST, the equipment being quickly installed when the need for shipborne operations arises.

HH-60Hs procured under the original Navy requirement for 18 'Rescue Hawks' were first delivered to two Naval Air Reserve Force squadrons, which were specially organised to provide the Navy's

SEALs abseil from an HH-60H. Two of these helicopters will be attached to each SH-60F unit for combat rescue and special operations.

primary response to contingency and wartime strike rescue operations and special warfare support. Navy requirement for HH-60Hs increased to 45 with the decision to give air wings an organic, quick-response strike warfare/special warfare capability by equipping helicopter anti-submarine squadrons with a four Ocean Hawk/two'Rescue Hawk' mix. Helicopter Combat Support Special Squadron Five (HCS-5 'Firehawks', 'NW') was established at NAS Point Mugu on 1 October 1988 and received its first HH-60H on 8 July 1989; HCS-4 'Red Wolves' ('NW') was established at NAS Norfolk on 23 September 1989 and received its first HH-60H on 3 February 1990. Both squadrons lost no time training to send detachments anywhere in the world for operations either from shipboard, as part of a naval task force, or independently from remote sites ashore. HCS-5 completed the first HH-60H carrier deployment aboard the USS *Nimitz* (CVN-68) in July 1990. Both squadrons were activated for Desert Shield/Desert Storm, two HH-60Hs, 50 active-duty and selected reserve HCS-5 aircrew and maintenance personnel being airlifted on 11 December 1990 to Tabuk, Saudi Arabia, aboard an Air Force C-5; a similar detachment from HCS-4 followed shortly thereafter. While in the Gulf, the two detachments flew more than 750 hours and their 'Rescue Hawks' were mission-ready more than 90 per cent of the time. With HELANTISUBRONs, HH-60Hs first deployed alongside SH-60Fs on 25 February 1991 when HS-2 went aboard the USS *Nimitz* (CVN-68).

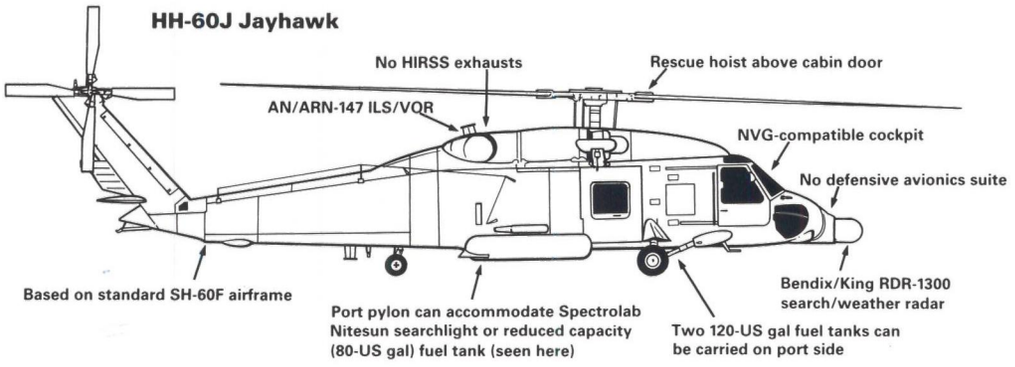
Based on experience during the Gulf War, improvements and updates are about to be introduced in the HH-60H fleet. They will include installation of a turreted Hughes AN/AAQ-16 FLIR, extended sponsons to house additional defensive systems, substitution of GECAL 0.50-in machine-gun for initially provided 7.62-mm M60D guns, and addition of forward-firing armament (initially to include 0.50-in machine-guns and 2.75-in rockets). The first 18 HH-60Hs will be retrofitted and the remaining 27 aircraft still to be procured will receive the additional systems and armament during production. Later, when funding can be obtained, provision for carrying defensive missiles, probably Sidewinder and/or Sidearm, is likely to be included.

BuNos: 163783/163800 and 164831/164846.

Right: The addition of HIRSS is the main external difference between the HH-60H and the SH-60F on which it is based. The aircraft are also often fitted with AN/ALE-39 chaff/flare dispensers.

Above: The HH-60H has two cabin windows on the port side, like Army utility Black Hawks. Various types of machine-gun can be carried.

HH-60J Jayhawk

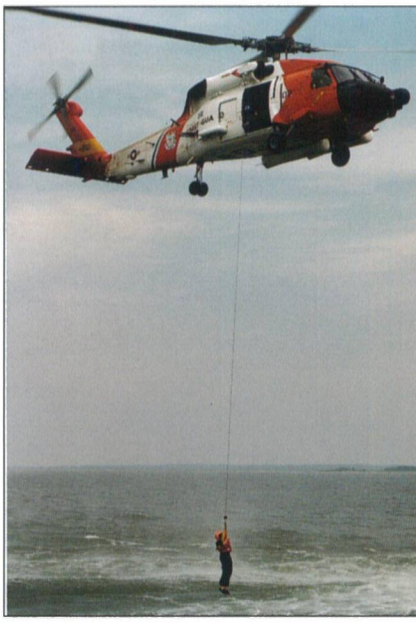

HH-60J Jayhawk
No HIRSS exhausts
Rescue hoist above cabin door
AN/ARN-147 ILS/VOR
NVG-compatible cockpit
No defensive avionics suite
Based on standard SH-60F airframe
Port pylon can accommodate Spectrolab Nitesun searchlight or reduced capacity (80-US gal) fuel tank (seen here)
Bendix/King RDR-1300 search/weather radar
Two 120-US gal fuel tanks can be carried on port side

Confusingly, the J suffix has been given not only to this version of the H-60 built to meet the medium-range recovery requirement of the US Coast Guard, but also to ASW and utility versions developed for Japan. Issued from the HCS/MRR requirement which also resulted in the closely-related HH-60H for the USN, the Jayhawk (a name derived from the J suffix in its designation, hence J Hawk, but duplicating that given by the Air Force to the Beech T-1A tanker/transport pilot trainer) was needed by the Coast Guard as a replacement for its 40 Sikorsky HH-3Fs. An initial order for two Jayhawks was placed in September 1986 and subsequent contract changes have increased to 35 the number of HH-60Js for which funding has been provided (Coast Guard serials 6001/6035 corresponding to BuNos 163801/163835, which have been given for contractual purposes as the Navy acts as purchasing agent for the Coast Guard). Twenty Jayhawks had been delivered by mid-June 1992. A second batch of 11 HH-60Js (BuNos 164820/164830) has now been ordered and the acquisition of 33 additional Jayhawks is likely to be funded as the supplemental request is being made to support Coast Guard drug interdiction operations.

The Coast Guard HH-60J is essentially similar to the Navy HH-60H but, not being called to operate in a combat environment, does not have provision for armament and dispenses with the comprehensive defensive suite and HIRSS exhaust suppression device of the 'Rescue Hawk'. Its mission avionics include a Bendix/King RDR-1300 search/weather radar in a thimble radome mounted centrally on the nose, a KDF-806 direction finder, and an AN/ARN-147 ILS/VOR receiver. Cockpit lighting is compatible with the use of night vision goggles, a 30-million candlepower Spectrolab SX-16 Nitesun searchlight can be mounted on the port side fuel tank pylon (as previously fitted to 'Pot Hawk' UH-60As of the Customs Service), and provision has been made for the installation of GPS equipment. As the Coast Guard's range and endurance requirements are greater than those of the Navy, the Jayhawk carries three instead of two 120-US gal (455-litre) external tanks, two on the port side and one on the starboard side, the asymmetric arrangement being dictated by the need to carry only one tank on the starboard side in order to clear the rescue hoist; in service, due to concerns over aft centre of gravity limits, the capacity of the right tank has been reduced to 80 US gal (303 litres). For its primary SAR mission, the Jayhawk is flown with a crew of four (two pilots, a flight engineer/hoist operator, and a rescue swimmer). When carrying three external tanks, it is capable of flying 300 nm (345 miles; 555 km) offshore, remaining on scene for 45 minutes and hoisting six survivors before returning to its point of origin with a safe fuel reserve. Secondary missions for the Jayhawk include ELT (Enforcement of Laws and Treaties) patrols and participation in OPBAT (Operations in the Bahamas and Turks Islands) on drug traffic interdiction missions, for which night vision goggles are proving most useful and for which the Coast Guard is requesting funding to retrofit its HH-60Js with AEL Series 2000 thermal imagers.

Below: The Coast Guard's HH-60J has a Bendix colour weather radar on the centreline.

Right: A Coast Guard Jayhawk winches a survivor from the water. The words 'Coast Guard' are painted below the belly.



The first HH-60J (USCG 6001) flew at Stratford on 8 August 1990 and, following test and evaluation during which minor changes were found necessary (fuel boost pumps being modified to improve reliability when using JP-4 fuel, the HF antenna installation being revised, and a searchlight being installed), Jayhawks first went to the Coast Guard's Aviation Technical Training Center (ATTC) at CGAS Elizabeth City, North Carolina, and to its Air Training Center (ATC) at CGAS Mobile, Alabama, during the summer of 1990. Deliveries to operating units were made to CGAS Elizabeth City in June 1991; to CGAS Traverse City, Michigan, and CGAS San Francisco, California, in October 1991; and to CGAS Cape Cod, Massachusetts, in January 1992. Other HH-60Js will go to Coast Guard Stations Kodiak and Sitka in Alaska and to CGAS Clearwater, Florida.

Although normally shore-based, HH-60Js can be fitted with RAST for operations aboard 'Hamilton'-class high-endurance cutters and 'Bear'-class medium-endurance cutters. Shipboard trials, during which a Jayhawk made 200 landings aboard the cutter *Escanaba* (WMEC 907), were completed in January 1992.

BuNos (USCG serials): 163801/163835 (USCG 6001/6035) and 164820/164830.

The starboard external fuel tank carried by the HH-60J is of reduced capacity because of concerns over centre of gravity limits. Only one can be carried to starboard to give clearance for the winch.

HS.23

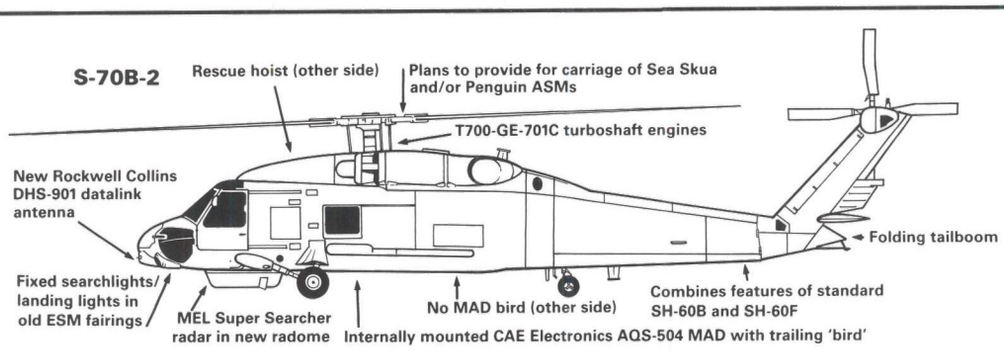
The Spanish naval designation HS.23 identifies 12 Seahawks ordered by the US Navy in 1983 for Spain's Arma Aérea de la Armada. The Spanish HS.23s, for which there is an unfunded requirement for four more, differ from USN SH-60Bs in being fitted with Bendix Oceanics AN/AQS-13F dipping sonar. Numbered HS.23-1 to HS.23-6, the first six Spanish Seahawks were ferried from Norfolk to Rota aboard the carrier *Principe De Asturias* (R 11) in December 1988 for assignment to Escuadrilla 010 at Rota and deployments aboard 'Santa Maria'-class guided missile frigates ('Oliver Hazard Perry' class built in Spain).

Spanish navy Seahawks are essentially similar to the US Navy's SH-60B but with different sonar. They fly from the main Armada air base at Rota, and deploy aboard frigates.

S-70B-2

The S-70B-2 designation identifies the Seahawk version selected by the Royal Australian Navy in October 1984 as its Role-Adaptable Weapons System (RAWS) for service aboard six 'Adelaide'-class guided missile frigates. The initial contract for this version, a $158.8-million award for eight aircraft, was announced on 31 July 1985.

The S-70B-2 RAWS combines features of both the SH-60B and SH-60F with an RAN-specified mission equipment package (MEP) integrated by Sikorsky and designed around American, Australian, British and Canadian sensors and avionics, including MEL Super Searcher X-band search radar in place of the AN/APS-124 as fitted to SH-60Bs, Rockwell Collins DHS-901 datalink and DTS-901 dataloader, CAE Electronics AQS-504 internally-mounted MAD system with MAD bird trailing 110 ft (35 m) behind and 50 ft (15 m) below the S-70B-2, and dual Rospatch AN/AAR-84 sonobuoy receiver. The S-70B-2 carries 25 Sonobuoys Australia SSQ-801 Barra sonobuoys with processing being done by a combination of a Computing Devices of Canada UYS-503 sonobuoy processor and an AQA-801 side processor. The S-70B-2 was also to be fitted for carrying


S-70B-2
Rescue hoist (other side)
Plans to provide for carriage of Sea Skua and/or Penguin ASMs
T700-GE-701C turboshaft engines
New Rockwell Collins DHS-901 datalink antenna
Folding tailboom
Fixed searchlights/ landing lights in old ESM fairings
MEL Super Searcher radar in new radome
No MAD bird (other side)
Combines features of standard SH-60B and SH-60F
Internally mounted CAE Electronics AQS-504 MAD with trailing 'bird'

Australia's S-70B-2 combines features of the SH-60B and SH-60F.

The first S-70B-2 was built by Sikorsky and carried a US civil registration and Dayglo test markings which incorporated a Dayglo kangaroo roundel.

Right: The third and subsequent S-70B-2s were locally assembled. The antenna for the aircraft's 360° MEL Super Searcher radar is housed in a smaller radome.

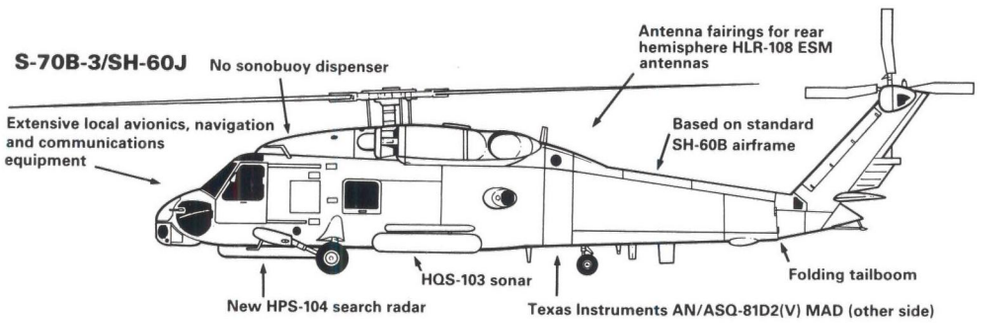
and guiding two Penguin Mk 2 Mod 7 or Sea Skua anti-ship missiles, but provision for anti-ship missiles has yet to be incorporated. Plans are also in hand for the eventual installation of a five-channel GPS receiver.

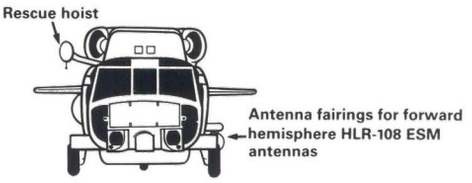
According to plans announced in October 1984, Sikorsky was to build the first two S-70B-2s and to provide CKDs for six S-70B-2s (this number being increased in May 1986 to 14, with serials N24-001 to N24-016) for assembly in Australia by Hawker de Havilland. The S-70B-2 first flew at West Palm Beach on 4 December 1987 and the two Sikorsky-built S-70B-2s were used to develop and evaluate the RAN-specified MEP. However, delays were encountered in the development programme due to difficulties with new systems integration while HDH experienced shortage of skilled personnel. Accordingly, the programme was revised so that the first eight S-70B-2s were assembled by Sikorsky while the final eight were assembled from CKDs by ASTA (Aerospace Technologies of Australia Pty Ltd) Military Aircraft Services at Lara, Victoria. The first two production standard S-70B-2s (with T700-GE-701C engines instead of the T700-GE-701s of the two prototypes) were respectively accepted at Stratford on 12 September 1989 and at RANAS Nowra, New South Wales, on 4 October 1989 (conditional acceptance pending ratification of operational software for their tactical data system). Sikorsky-built S-70B-2s went into service with HS 816 and made their first operational deployment in August 1990 aboard 'Adelaide'- and 'Darwin'-class guided missile frigates bound for Middle Eastern waters to take part in the maritime blockade imposed by the United Nations against Iraq. (For service in the Persian Gulf, which began when the frigates arrived on station on 3 September 1990 and lasted until the conclusion of Desert Storm, the two deployed S-70B-2s were fitted with AN/AAQ-16 FLIR, AN/ALE-47 chaff/flare dispensers, and AN/AAR-47 missile detectors.) Delivery of ASTA-assembled S-70B-2s commenced during the following month.

S-70B-3
(Japanese YSH-60J and SH-60J)

To replace HSS-2Bs equipping nine ASW squadrons, the JMSDF has long had a requirement for a minimum of 75 SH-60Js (48 to be ship-based for service aboard 'Shirane'-, 'Haruna'- and 'Asagiri'-class helicopter-carrying destroyers and 'Atakaze'- and 'Hatsuyuki'-class guided missile destroyers, 20 for service with land-based units, and seven for attrition), with procurement possibly increasing in stages to a total of 200 SH-60Js. However, the Japanese Seahawk programme has had a long gestation. It was initiated in 1983, when the Technical Research and Development Institute of the Japanese Defence Agency began funding detailed design work on an SH-60B version to be fitted with much Japanese avionics and equipment, but was only finalised in August 1988 when Mitsubishi Jukogyo KK and Sikorsky concluded their negotiations for a licensing agreement providing for the manufacture of H-60 variants in Japan. Locally developed systems include a tactical display system, a datalink, a ring laser gyro attitude/heading reference system, automated flight management systems, HQS-103 sonar, HPS-104 search

The first XSH-60J. The first two Japanese Seahawks were assembled by Sikorsky, and looked very much like SH-60Bs.


S-70B-3/SH-60J
No sonobuoy dispenser
Antenna fairings for rear hemisphere HLR-108 ESM antennas
Extensive local avionics, navigation and communications equipment
Based on standard SH-60B airframe
HQS-103 sonar
Folding tailboom
New HPS-104 search radar
Texas Instruments AN/ASQ-81D2(V) MAD (other side)



The first Mitsubishi-built SH-60J differs from the SH-60B in many respects, with new avionics fairings and antennas.

Right: The first S-70B-3 in flight carries a US civilian registration on the rear fuselage.

radar and HLR-108 ESM suite. They are integrated with imported systems including a Texas Instrument AN/ASQ-81D2(V) MAD, a General Instruments AN/ALR-66(VE) radar warning receiver, and an Ednac AN/ARR-75 sonobuoy receiver.

Two S-70B-3s, similar to SH-60Bs but without the sonobuoy dispenser on the port side, were imported in 'green airframe' condition and were designated XSH-60Js in Japan. Reassembled and fitted with its indigenous avionics/sensor suite by Mitsubishi, the first XSH-60J (JMSDF serial 8201) flew at Komaki, Nagoya, on 31 August 1987. Mitsubishi-built SH-60Js, of which 56 had been ordered by FY92, have been given JMSDF serials 8203 to 8258. Operational evaluation was completed by the 51st Kokutai at Atsugi at the end of 1990 and initial operational capability was achieved at the end of the following year.

S-70B-6

Under a $161-million contract awarded in January 1992, Greece is to acquire five S-70B-6 ASW helicopters for operations from Blohm und Voss MEKO 200 frigates being built by Hellenic SY. The S-70B-6s, for which Sikorsky will be systems integrator, will be SH-60B/SH-60F hybrids with Bendix AN/ASQ-18(V)3 active dipping sonar, Eaton AN/APS-143(V)3 pulse compression surveillance radar compatible with the Penguin missile, General Instruments AN/ALR-606(V)2 threat-warning system, Teledyne tactical data system, and French-developed Samahe harpoon system. Deliveries to the Elliniki Pterix Naftica are to take place in 1995-96.

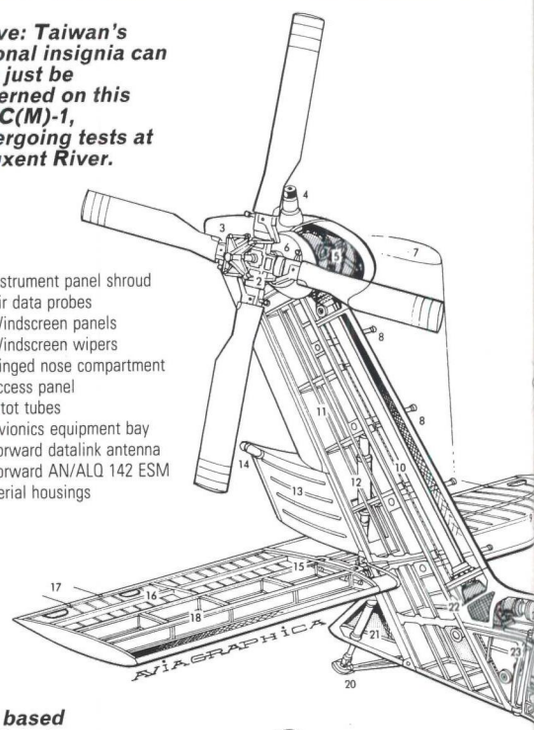
S-70C(M)-1 Thunderhawk

The Republic of China Navy has ordered 10 S-70C(M)-1 Thunderhawks for operations from six 'Kwang Hua I'-class ('Oliver Hazard Perry'-class) guided missile frigates being built in Taiwan. Notwithstanding their military role, these helicopters have been given a designation in the pseudo-civilian S-70C series. Using airframes essentially similar to those of SH-60Fs, the Thunderhawks have been fitted with Sikorsky-integrated systems including Telephonics AN/APS-128C pulse compression radar, Bendix Oceanics AN/AQS-18(V) dipping sonar, Teledyne AN/ASN-150 tacnav system, and Litton AN/ALR-606(V)2 electronic support measures. Some have Indal RAST while others use the French Samahe harpoon system. Operational testing was conducted at NATC Patuxent River during the second half of the 1990s and Thunderhawks will deploy aboard ROC frigates beginning in 1993.

Above: Taiwan's national insignia can only just be discerned on this S-70C(M)-1, undergoing tests at Patuxent River.

Sikorsky SH-60B Seahawk

1 Graphite epoxy composite
2 Lightweight cross beam rotor hub
3 Blade pitch change spider
4 Anti-collision light
5 Tail rotor final drive bevel gearbox
6 Rotor hub canted 20°
7 Horizontal tailplane–folded position
8 Pull-out maintenance steps
9 Port tailplane
10 Tail rotor drive shaft
11 Fin pylon construction
12 Tailplane hydraulic jack
13 Cambered trailing edge section
14 Tail navigation light
15 Tailplane hinge joint (manual folding)
16 Handgrips
17 Static dischargers
18 Starboard tailplane construction
19 Towed magnetic anomaly detector (MAD)
20 Tail bumper
21 Shock absorber strut
22 Bevel drive gearbox
23 Tail pylon latch joint
24 Tail pylon hinge frame (manual folding)
25 Transmission shaft disconnect
26 Tail rotor transmission shaft
27 Shaft bearings
28 Tail pylon–folded position
29 Dorsal spine fairing
30 UHF aerial
31 Tailcone frame and stringer construction
32 Magnetic compass remote transmitters
33 MAD detector housing and reeling unit
34 Tail rotor control cables
35 HF aerial cable
36 MAD unit fixed pylon
37 Ventral datalink antenna housing
38 Lower UHF/TACAN aerial
39 Fuel jettison
40 Anti-collision light
41 Tie down shackle
42 Tailcone joint frame
43 Air system heat exchanger exhaust
44 Engine exhaust shroud
45 Emergency locator aerial
46 Engine fire suppression bottles
47 IFF aerial
48 Port side auxiliary power unit (APU)
49 Oil cooler exhaust grille
50 Starboard side air conditioning plant
51 Engine exhaust pipe
52 HF radio equipment bay
53 Sliding cabin door rail
54 Aft AN/ALQ-142 SM aerial fairing, port and starboard
55 Tailwheel leg strut
56 Fireproof fuel tanks, port and starboard, total capacity 361 US gal (1367 litres)
57 Starboard stores pylon
58 Castoring twin tailwheels
59 Torpedo parachute housing
60 Mk 46 lightweight torpedo
61 Cabin rear bulkhead
62 Passenger seat
63 Honeycomb cabin floor panelling
64 Sliding cabin door
65 Recovery assist, secure and traverse (RAST) aircraft hauldown fitting
66 Ventral cargo hook, 6,000-lb (2722-kg) capacity
67 Floor beam construction
68 Spring-loaded door segment in way of stores pylon
69 Pull-out emergency exit window panel
70 Pneumatic sonobuoy launch rack (125 sonobuoys)
71 Rescue hoist/winch
72 General Electric T700-GE-401 turboshaft engine
73 Engine accessory equipment gearbox
74 Intake particle separator air duct
75 Engine bay firewall
76 Oil cooler fan
77 Rotor brake unit
78 Engine intake ducts
79 Maintenance step
80 Engine drive shafts
81 Bevel drive gearboxes
82 Central main reduction gearbox
83 Rotor control swash plate
84 Rotor mast
85 Blade pitch control rods
86 Bi-filar vibration absorber
87 Rotor head fairing
88 Main rotor head (elastomeric, non-lubricated bearings)
89 Blade pitch control horn
90 Lead-lag damper
91 Individual blade folding joints, electrically actuated
92 Blade spar crack detectors
93 Blade root attachment joints
94 Main rotor composite blades
95 Port engine intake
96 Control equipment sliding access cover
97 Engine-driven accessory gearboxes
98 Hydraulic pump
99 Flight control servo units
100 Flight control hydro-mechanical mixer unit
101 Cabin roof panelling
102 Radar operator's seat
103 AN/APS-124 radar console
104 Tiedown shackle
105 Gearbox and engine mounting main frames
106 Maintenance steps
107 Main undercarriage leg mounting
108 Shock absorber leg strut
109 Starboard mainwheel
110 Pivoted axle beam
111 Starboard navigation light
112 Cockpit step/main axle fairing
113 Forward cabin access panel
114 Collective and cyclic pitch control rods
115 Sliding fairing guide rails
116 Cooling air grille
117 Main rotor blade glass-fibre skins
118 Honeycomb trailing edge panel
119 Titanium tube blade spar
120 Rotor blade drooped leading edge
121 Leading edge anti-erosion sheathing
122 Fixed trailing edge tab
123 Cockpit eyebrow window
124 Rear view mirrors
125 Overhead engine throttle and fuel cock control levers
126 Circuit breaker panel
127 Pilot's seat
128 Safety harness
129 Crash-resistant seat mounting
130 Pull-out emergency exit window panel
131 Flight deck floor level
132 Cockpit door
133 Boarding step
134 AN/APS-124 search radar antenna
135 Ventral radome
136 Retractable landing/hovering lamp
137 Downward vision window
138 Yaw control rudder pedals
139 Cyclic pitch control column
140 Instrumental panel
141 Centre instrument console
142 Stand-by compass
143 ATO/co-pilot's seat
144 Outside air temperature gauge
145 Instrument panel shroud
146 Air data probes
147 Windscreen panels
148 Windscreen wipers
149 Hinged nose compartment access panel
150 Pitot tubes
151 Avionics equipment bay
152 Forward datalink antenna
153 Forward AN/ALQ 142 ESM aerial housings



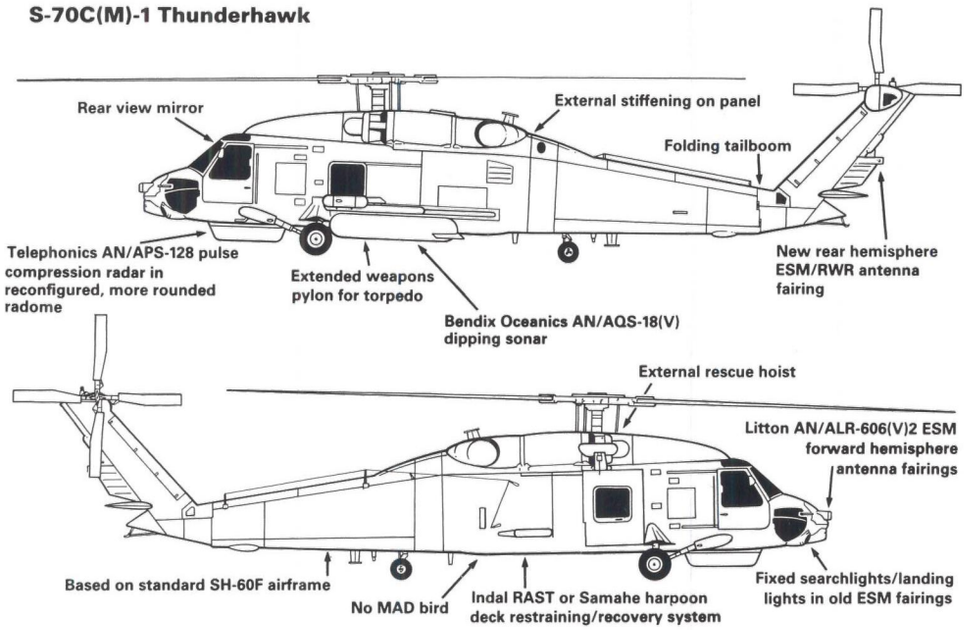
Below: The Thunderhawk is based on the airframe of the SH-60F, but has an undernose search radar and a new ESM system.

Specification

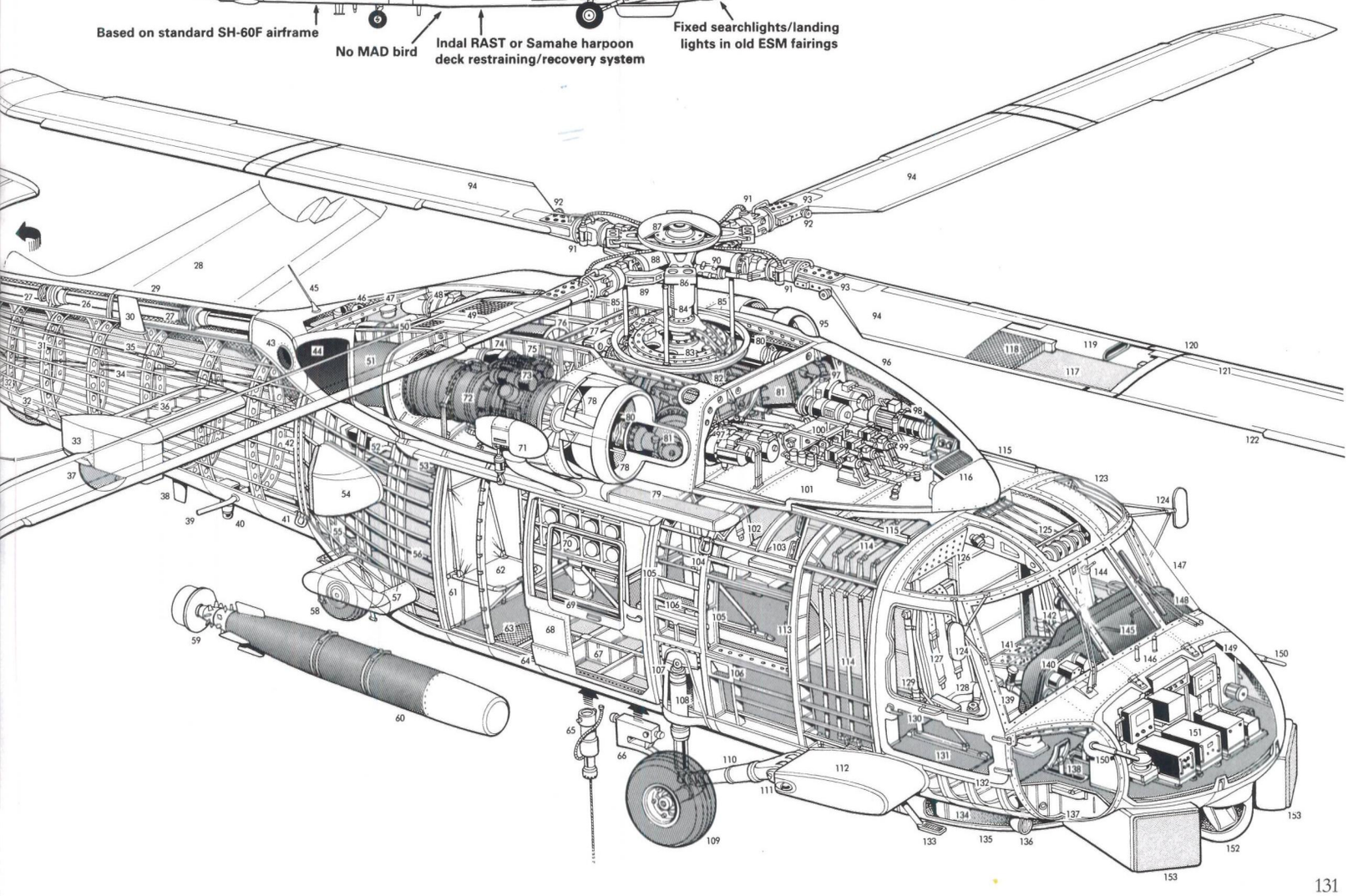
	UH-60A	SH-60B	HH-60G
Main rotor diameter	53 ft 8 in (16.36 m)	53 ft 8 in (16.36 m)	53 ft 8 in (16.36 m)
Overall length (rotor turning)	64 ft 10 in (19.76 m)	64 ft 10 in (19.76 m)	64 ft 10 in (19.76 m)
Overall length (refuelling probe extended)	64 ft 10 in (19.76 m)	64 ft 10 in (19.76 m)	68 ft 9.5 in (20.97 m)
Fuselage length (refuelling probe retracted)	50 ft 0.75 in (15.26 m)	57 ft 0.75 in (15.26 m)	50 ft 0.25 in (17.38 m)
Height (tail rotor turning)	16 ft 10 in (5.13 m)	17 ft 0 in (5.18 m)	16 ft 10 in (5.13 m)
Main rotor disc area	2262 sq ft (210.2 m^2)	2262 sq ft (210.2 m^2)	2262 sq ft (210.2 m^2)
Empty weight	11,285 lb (5120 kg)	13,650 lb (6190 kg)	12,400 lb (5625 kg)
Typical mission weight	17,000 lb (7710 kg)	20,250 lb (9185 kg)	15,700 lb (7120 kg)
Max take-off weight	22,000 lb (9980 kg)	21,885 lb (9925 kg)	20,250 lb (9185 kg)
Max disc loading	9.7 lb/sq ft (47.5 kg/m^2)	9.7 lb/sq ft (47.2 kg/m^2)	9.0 lb/sq ft (43.7 kg/m^2)
Max power loading	7.1 lb/shp (4.3 kg/kW)	5.8 lb/shp (3.5 kg/kW)	6.5 lb/shp (4.0 kg/kW)
Max speed	184 mph at sl* (296 km/h at sl)	145 mph at 5,000 ft (233 km/h at 1525 m)	180 mph at sl (290 km/h at sl)
Cruising speed	167 mph (269 km/h)	130 mph (209 km/h)	160 mph (257 km/h)
Vertical rate of climb	450 ft/min (2.3 m/sec)	n/a	425 ft/min (2.2 m/sec)
Normal range	375 miles (600 km)	n/a	425 miles (680 km)
Ferry range	1,380 miles (2210 km)	n/a	560 miles (895 km)

* sl = sea level

S-70C(M)-1 Thunderhawk


Rear view mirror
External stiffening on panel
Folding tailboom
Telephonics AN/APS-128 pulse compression radar in reconfigured, more rounded radome
Extended weapons pylon for torpedo
Bendix Oceanics AN/AQS-18(V) dipping sonar
New rear hemisphere ESM/RWR antenna fairing
External rescue hoist
Litton AN/ALR-606(V)2 ESM forward hemisphere antenna fairings
Based on standard SH-60F airframe
No MAD bird
Indal RAST or Samahe harpoon deck restraining/recovery system
Fixed searchlights/landing lights in old ESM fairings

A close-up view of the nose of a Thunderhawk clearly shows the new nose radome contours and new ESM antennas.



Croatian Air Force

Photographed by Dragiša Brašnović

Croatia followed Slovenia in unilaterally seceding from the Yugoslav federation, and had to fight hard for its independence. Although Croatian forces are involved in the war in neighbouring Bosnia, the ceasefire in the Croatian republic has held with policing from UN forces. The basis of the Hrvatske Zračne Snage (Croatian air force) has been provided by civilian aircraft based locally, and defections from the former Yugoslav air force (JRV).

Above: UTVA 75 light aircraft were supplied to most aero clubs in former Yugoslavia. Several serve in military colours.

Below: A hastily-camouflaged Cessna 172 wears the 'HZS' title which reflects the change of name for the Croatian air force.

Several agricultural aircraft have been impressed into HRV/HZS service, some with wing racks for light bombs. These have included a Cessna 188, a PZL Dromader and this Air Tractor.

Above and right: The Antonov An-2 proved very important to Croatian forces during the war, being used for supply flights, medevac duties and as a makeshift bomber. One of the aircraft above is shown with national insignia removed, a necessary measure as the large crest made the 'Colts' highly visible to Serbian gunners.

Left: This MiG-21 demonstrates the new Croatian colours with a red/white/black fin-stripe with the Croatian crest superimposed. The crest (inset) is the official air force insignia, known as the 'chess-plate'.

Affectionately nicknamed 'Old Girl', this Mil Mi-8 gave sterling service during the war. The 'HV' stands for Hrvatska Vojska, and was carried as an identification mark. The badges within the Croatian crest represent the five regions which make up the republic.

Three MiG-21s have served in Croatian colours, registered 101, 102 and 103 but only carrying the numerals on the wing. 101 was shot down during the war. This machine demonstrates the early insignia style with the Croatian crest replacing the red star on the JRV fin band.

The Croatian air force was known as the HRZ (Hrvatsko Ratno Zrakoplovstvo). This An-2, a veteran from the fighting at Vukovar, carries the marten badge of the Slavonia region.

Southern Asia

Southern Asia is one of the world's great trouble spots. An ongoing feud between India and Pakistan, its two largest and most powerful nations, has twice erupted into bloody warfare during the last 30 years. Both protaganists have also had border clashes with other neighbours: India with China, and Pakistan with Afghanistan. India and Pakistan are not the only nations which have used air power in anger, however. Nearby Sri Lanka, for example, is presently engaged in putting down a long-running insurrection by Tamil separatists. Although the bloody war against the Communist regime in Afghanistan is over, it has been replaced by an equally devastating struggle for power by opposing Mujahideen groups. Following our Air Power Analysis on India in *World Air Power Journal*, Volume 12, we present descriptions of and orders of battle for the air arms of Afghanistan, Bangladesh, Nepal, Pakistan, Sri Lanka and the Seychelles.

This Su-22M-4 'Fitter-K' defected to Pakistan, providing Western intelligence agencies with a welcome gift. Three-digit nose-codes are standard on front-line fighters.

Below: Another defector is pictured in Pakistan, this time a Mikoyan MiG-21bis. Afghan MiG-21s were used primarily in the ground attack role, using bombs and unguided rockets.

Democratic Republic of Afghanistan

Afghan Hanai Qurah/Afghan Republican Air Force

The exact status and strength of the Afghan Republican Air Force is clouded by the secretive nature of the previous Communist regime, and by the long-running war against the Mujahideen, during which Soviet aircraft were frequently deployed to Afghanistan, sometimes wearing Afghan markings, and sometimes being donated to the indigenous air arm at the end of a deployment. The overthrow of President Najibullah and the resulting power struggle between the Pathan Hezb-E-Islami leader Gulbuddin Hekmatyar and a loose alliance of Tajik guerrillas and Uzbek and Turkmen militias has further muddied the waters.

Even before the overthrow of Najibullah and the installation of an Islamic government in April 1992, the air force had been growing progressively less effective, with a growing cut-off of spare parts, fuel, advisers and training as the Soviet Union itself fell apart.

The air force theoretically retained its old organisation and structure under the Islamic government, albeit now known as the Air and Air Defence Force of the Islamic State of Afghanistan, and although a new Commander in Chief was appointed in October 1992, with a brief to Islamicise his force, this was largely window-dressing to camouflage the fact that there was no single effective air arm.

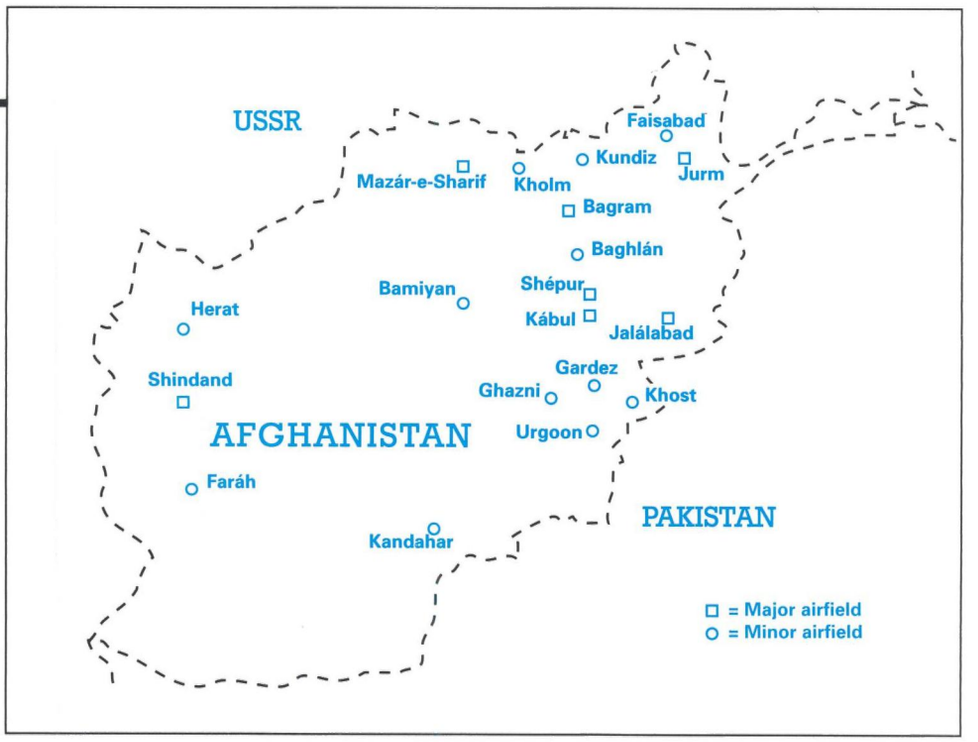
The educated elite of Afghanistan was largely loyal to the previous regime, and in the present situation such individuals have been forced to flee for their lives or face execution. Their natural loyalty would ordinarily be to the Pathan leadership, but this leadership was under fierce attack by Hekmatyar who urged a more far-reaching purge of soldiers and technocrats who had served the old regime. Remarkably, there was no widespread purge of what remained of the air force, not least because any such purge would have totally destroyed the tiny, but still useful asset. This was particularly astonishing since the air force, as a technical service, had always been most reliant on its officer corps, and had always remained loyal to the Communist regime. While the Afghan army dropped from 80,000 in 1979 to 30,000 in the late 1980s, mainly as a result of desertions, air force strength remained constant. With the fall of Najibullah, however, the air force fell apart, splintering into factions which were determined chiefly by geography. Thus while forces at Kabul and nearby Bagram went over to Massoud, Mazar-e-Sharif went over to the local warlord, General Abdul Rashid Dostam, and Shindand to Gulbuddin Hekmatyar.

When Massoud made his initial push on Kabul he was supported by two Mil Mi-17s which had been captured in previous years, and when he gained control of the units at Bagram and Kabul he gained an invaluable weapon. Antonov An-12s from Kabul were used to shuttle Dostam's fighters from Mazar-e-Sharif to Kabul to join the fighting alongside Massoud and his allies from the old armed forces, and thereby prevent Hekmatyar and his allies from the Ministry of the Interior troops from seizing power.

Hekmatyar tried to seize power again in August 1992, mounting rocket attacks against Kabul. The government's response included airstrikes by fighter-bombers and helicopter gunships, and airlifts of loyal troops by An-12 and helicopter. Fighter-bombers from Mazar-e-Sharif also attacked Shindand, cratering the runways and knocking out many of the 85 aircraft based there. This prevented Hekmatyar from mounting his own airstrikes until October, by which time he had only seven

A line-up of Aero L-39s is seen at Sherpur. These aircraft wear two different colour schemes, one a red and white training scheme, the other a more business-like camouflage. The aircraft are used for advanced training.

Above: Ever resourceful, these Mujahideen guerrillas have converted a crashed Mil Mi-8, post-invasion roundel just visible, into a makeshift body for a captured Soviet army lorry.



Above: The majority of Afghanistan's major airfields are clustered in the north-east of the country, in the areas previously controlled by the government and their Soviet allies. Only a handful of bases remain in operation at all, and flying operations are sporadic, restricted by serviceability, fuel, and trained pilots.

Left: Afghan air force aircraft have worn a variety of national insignia since the Soviet invasion in 1979. This 'Hind-D's' red disc did not last long.

Afghanistan was one of the last air forces to use the MiG-17 as a front-line fighter-bomber. Here pilots from the 393rd Fighter Bomber Regiment walk away from their aircraft.

The Mil Mi-24 'Hind' was used (and shot down) in large numbers. Here a group of Mujahideen fighters inspect a newly defected example of the 'Hind-D' in 1988.

operational aircraft and three pilots. The two surviving fighter-bombers were flown out to Jalalabad shortly before government forces re-took Shindand.

Fighting broke out around Kabul in December 1992, due to tensions between Massoud, Dostam, and Shia militias. Dostam threatened to call in his fighter-bombers from Mazar-e-Sharif, but the situation was defused by Su-25s from Bagram, which circled over Kabul to demonstrate their loyalty to the government.

The major operational air bases are Bagram, Kabul International, Mazar-e-Sharif and Shindand, while Jalalabad, Kandahar, Khost, and Herat also represent well-equipped major airfields. Other military airfields include Baglan, Bamiyan, Dehdadi (a satellite of Mazar-e-Sharif), Faisabad, Farah, Ghazni, Gardez, Jurm, Kunduz and Sherpur. For the record, this Air Power Analysis includes a description of and provisional order of battle for this once-impressive air arm.

Known as the Royal Afghan Air Force until July 1973, when the monarchy was overthrown, the air arm was formed as an integral part of the army in 1924, receiving a squadron of bombers from the USSR as a gift one year later. For many years the air force procured aircraft from the USSR, Britain and Italy, but since 1978, when the Communist Khalq (Masses) party seized power, the air arm has been entirely Soviet equipped, and organised along Soviet lines. Even as early as 1955 Soviet aid was predominant, with a massive training, re-equipment and airfield building programme. Soviet aid between 1955 and 1973 totalled $1,500 million, three times the aid received from the USA over the same period. Between December 1979 and February 1989 Soviet troops and aircraft were stationed in Afghanistan in large numbers, and the USSR built six airfields to accommodate these forces.

Before the Soviet involvement in Afghanistan, the air force was largely equipped with obsolescent types, with an interceptor regiment of early MiG-21s, a fighter regiment with MiG-17s and MiG-19s (and MiG-15UTIs for training), an Su-7-equipped fighter-bomber regiment and a light bomber regiment (355 Regiment) with three squadrons of Ilyushin Il-28 'Beagles'. The transport arm was equipped largely with Ilyushin Il-14s, Antonov An-2s and Mil Mi-4 helicopters. Of these, only the MiG-21s, MiG-17s, Su-7s and transports remained in use by the late 1980s, augmented by large numbers of more modern aircraft.

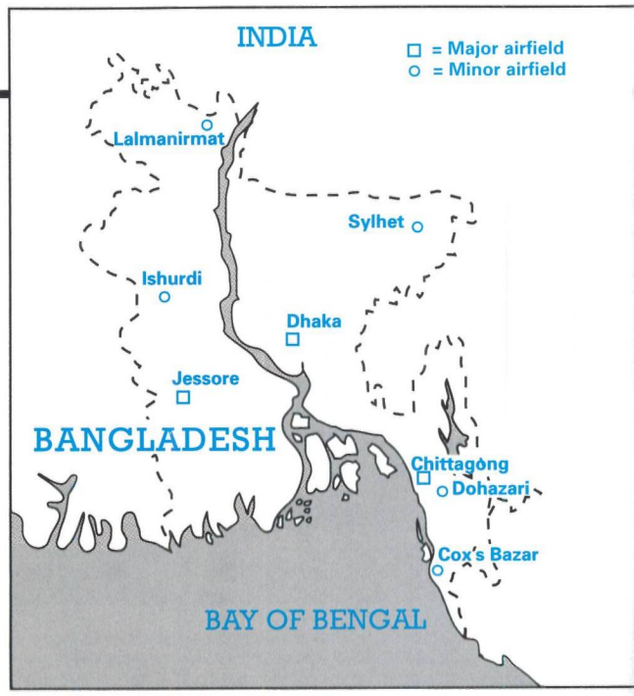
Confusion surrounds the exact details of Soviet transfers to the Afghan Republican Air Force, which have included about 24-30 MiG-23 'Floggers', late-mark MiG-21 'Fishbeds', 10-20 Sukhoi Su-22 'Fitter-Ks', Mil Mi-24s, Mil Mi-25s and Mil Mi-35s, Mil Mi-8s and Mil Mi-17s, and 18-24 Aero L-39 Albatros trainers, as well as Antonov An-12, An-14, An-24, An-26, An-30 and An-32 transports. Helicopters and MiG-21s bore the brunt of the war against the Mujahideen, and were shot down (and replaced) in large numbers. Defectors' reports suggested that some 164 aircraft were lost between 1979 and 1983 (in addition to Soviet aircraft and helicopters) and this rate of attrition continued. Some reports also suggest that about 50 Su-25 'Frogfoot' ground attack aircraft were transferred, but this cannot be confirmed, nor can reports that a handful of MiG-29s were delivered, although contracts for MiG-29s and Su-27s were reportedly signed in 1989.

Eight major air bases and about 30 other military airfields include Bagram, Bhaglan, Dehdadi, Faisabad, Farah, Ghazni, Gardez, Herat, Jalalabad, Jurm, Kandahar, Kabul, Kholm, Khost, Kundiz (Qonduz), Mazar-I-Sharif, Sherpur, Shindand, Urgoon.

The order of battle given below attempts to detail the status of the Afghan Republican Air Force as it was immediately after the Soviet withdrawal, but should be regarded as provisional. In particular, some reports suggest that all two-seat trainer versions of front-line combat aircraft are concentrated together in a single OCU unit, but this seems unlikely.

Order of Battle

UNIT	EQUIPMENT	BASE
321 Fighter-bomber Regiment	Su-17, Su-25	Bagram
322 Fighter-Interceptor Regiment	MiG-21/U, -23MF/UB	Bagram
332 Combat Helicopter Regiment	Mil Mi-24/-25/-35 Disbanded?	Jurm
355 Fighter-bomber Regiment	Formerly Il-28 Now Su-22M4, Su-25, MiG-27	Shindand
375 Combat Helicopter Regiment	Mil Mi-8/-17/-25	Mazar-e-Sharif
377 Combat Helicopter Regiment	Mil Mi-8/-17/-25	Kabul
393 Fighter-bomber Regiment	Formerly MiG-17, -15UTI, Su-25, MiG-21	Mazar-e-Sharif
Flying Training School	Yak-11, Yak-18, Aero L-29, L-39	Sherpur
	L-39s may have moved to Mazar-e-Sharif	
Operational Training Unit	MiG-21, Mil Mi-8	Mazar-e-Sharif
??? Transport Regiment	An-12, An-26, An-30, An-32	Kabul
??? Liaison/light transport squadron	An-2, An-14(?), Il-14	Kabul
VIP squadron	Il-18, Mil Mi-8, An-24	Kabul



Bangladesh's vulnerability to catastrophic floods is partly due to the multitude of rivers flowing south into the Indian Ocean and to the position of the Jammu estuary.

This North American F-86 Sabre is now in the museum at Dhaka. Five were taken over from Pakistan's No. 14 Squadron (based in East Pakistan) after independence, and others were flown to Bangladesh by defectors.

This AESL CT-4 Airtrainer was the sole example of the type delivered to Bangladesh, having been donated by New Zealand during the 1970s. It now survives with the air force museum.

This single Scheibe SF-25C-2000 Falke motor glider is used by the Air Force Academy at Jessore for air experience and recreational flying.

People's Republic of Bangladesh

Bangladesh Biman Bahini/ Bangladesh Defence Force Air Wing

Formerly the Eastern Province of Pakistan, and geographically separated from the parent country by India, Bangladesh gained its independence in December 1971, after months of bloody civil war and a 14-day war of independence. As one of the world's most poverty-stricken nations, and one which is regularly devastated by extensive floods, Bangladesh has a very limited military budget and relies heavily on foreign aid for equipment and training. Continuity has been further fragmented by political instability, with brief periods of democratic government being interspersed with long periods of military rule. Transport aircraft and helicopters have an enormous importance in the air force, and are frequently used for disaster relief operations.

The country's air arm was formed during 1971 as the air wing of the Mukti Bahini separatist forces, with Indian assistance. It operated some four DHC-3 Otters and a single DHC-4 Caribou donated by India, and these played a minor role in the struggle for independence from Pakistan's military government. After independence, Bangladesh continued to receive aid from India, and received four HAL Chetak (Alouette III) helicopters and a pair of C-47s. The air arm also took over five Canadair Sabre Mk 6s and a single T-33 previously operated by the Pakistan air force. Defectors from the latter air arm allowed the formation of a Sabre-equipped combat element.

Indian influence declined steadily after Bangladeshi Prime Minister Sheikh Mujibur Rahman visited Moscow in 1972. While there he negotiated an agreement which gave the air arm's pilots three-month training courses in the USSR and a shipment of 12 Mikoyan MiG-21MF 'Fishbed-Js' and two MiG-21U 'Mongols', which arrived at Chittagong in early 1973. These initially equipped a mixed fighter unit at Tezgaon, before spares shortages led to the grounding of the Sabres and T-33. The fighters were soon followed by some six Mil Mi-8 helicopters, a single An-24 and a Yak-40. Other foreign governments also donated equipment to the infant air arm, New Zealand sending a single CT-4 Airtrainer and Britain two Westland Wessex HU.Mk 5s. Iran later donated a pair of Agusta-Bell AB 205s. Relations with India, however, declined further after the August 1975 coup which resulted in the death of Sheikh Rahman, and have continued to be frosty due to allegations of Indian support for the Shanti Bahini (Army of Peace) rebels operating in the east of the country.

The Nanchang BT-6 is used by No. 11 Squadron at Jessore for primary training. Twelve were delivered.

Below: Some of No. 11 Squadron's Nanchang BT-6s wear a more operational dark green colour scheme.

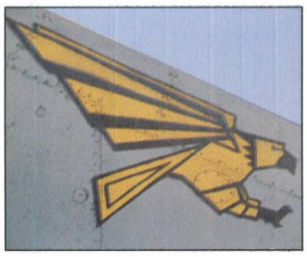
Left: Two F-7Ms of No. 35 'Thundercats' Squadron, in a two-tone dark grey air defence colour scheme.

Above: No. 15 Squadron's six surviving Fouga CM.170 Magisters are co-located beside No. 11's BT-6s.

Above: Each F-7M squadron also operates a single Guizhou FT-7 two-seater. This one belongs to No. 35.

Below: No. 5 Squadron, based at Dhaka, flies the F-7M. This one carries PL-7 AAMs.

Right and below: All Bangladeshi F-7Ms wear the unit badges of both squadrons, No. 35 'Thundercats' Squadron's logo on the nose and No. 5 'Supersonics' Squadron's eagle on the fin. This is particularly unusual since the two squadrons are not co-located.



Left: No. 25 Squadron at Chittagong acts as an OCU and tactical training unit, using Shenyang F-6 fighters and FT-6 trainers.

This is the squadron badge of No. 25 Squadron, the 'Trendsetters', the last F-6 unit in Bangladesh.

By 1977, when four MiG-21s were destroyed by the army in an unsuccessful coup attempt, three aircraft had already been lost in accidents and four more were sabotaged, leaving only three operational aircraft. The USSR had by this time been replaced by China as the main source of foreign aid, and China was approached with a request to restore the operational capability of the air force. The first priority was the provision of replacements for the MiG-21s (the three survivors were grounded by spares shortages), and these came in the form of 24 Shenyang F-6s (Chinese-built MiG-19s), with four two-seat FT-2s (MiG-15UTIs) for training. These equipped the fighter squadron at Tezgaon and a newly formed unit at Jessore.

Since the supply of ex-Pakistan air force pilots had dried up, and since many experienced pilots had been shot during the 1977 coup, there was an urgent need for *ab initio* training. During 1979 China therefore helped establish a flying training school at Jessore, initially equipped with 12 Nanchang BT-6s. More of these aircraft have since been delivered, and are augmented by the six survivors from six ex-Luftwaffe, four ex-Armée de l'Air aircraft and five ex-Togolese Fouga Magisters, all of which were refurbished by Aérospatiale prior to delivery (respectively in 1977, 1980 and 1985). Students fly 25 hours on the BT-6 before going on to 150 hours on the Magister. In recent years most conversion training has been conducted overseas.

During the early 1980s the helicopter and transport force was expanded and rationalised, with the Wessexes being retired by 1979. The Chetaks and AB 205s were sold and some 10 Bell 212s being procured. In addition, the air wing operates two Bell 206Ls on behalf of the Ministry of Family Planning, and for rotary wing training. The two ex-Indian C-47s were replaced by a trio of An-26s, which themselves gave way to two An-32s in mid-1989.

During the late 1980s, an increase in foreign aid allowed further expansion. In 1987 the UAE donated $15 million to allow the purchase of utility helicopters for flood relief duties. The money went on three more Bell 212s, two in VIP configuration. Planned procurement of three IPTN NAS-332 Super Pumas seems to have been abandoned, however. In 1992, the arrival of a single Mil Mi-17 marked the beginning of the end for the Mil Mi-8, with four more expected before the end of the year.

More controversially, the combat arm of the air force has been considerably expanded, with the delivery of some ex-Pakistani F-6s in 1990 (some sources say they were delivered in the mid-1980s), following their replacement in PAF service by F-16s and F-7Ps. Many of these F-6s were destroyed in the April/May 1991 floods which hit the country. One of the two F-6 squadrons has converted to A-5s (in 1986), and a second A-5 and two new F-7M units have now formed with aircraft from China.

Order of Battle

UNIT	EQUIPMENT	BASE
Training units		
Air Force Academy	Scheibe SF-25C	Jessore
No. 11 Sqn	Nanchang BT-6	Jessore
No. 15 Sqn	Fouga CM.170 Magister	Jessore
Fighter units		
No. 5 Sqn 'Supersonics'	Chengdu F-7M Skybolt	Dhaka
No. 35 Sqn 'Thundercats'	Chengdu F-7M Skybolt	Chittagong
No. 25 (OCU) Sqn 'Trendsetters'	Shenyang F-6	Chittagong
Fighter-bomber units		
No. 8 Sqn	Nanchang A-5C	Chittagong
No. 21 Sqn	Nanchang A-5C	Dhaka
Transport units		
No. 1 Sqn	Mil Mi-8/17	Chittagong
No. 3 Sqn	Antonov An-32	Jessore
No. 18 Sqn	Bell 206L	Jessore
No. 31 (VIP) Sqn	Bell 212, Mil Mi-8	Dhaka

An FT-6 of No. 25 Squadron wears the latest F-7M style two-tone dark grey colour scheme.

Below: No. 25 Squadron also uses the air force's surviving single-seat Shenyang F-6s.

This Bell 206L LongRanger is used for advanced rotary wing training by No. 18 Squadron at Jessore.

Below: One Mil Mi-8 'Hip-C' is used by No. 31 Squadron for VIP duties, and wears a white and blue scheme.

Kingdom of Nepal

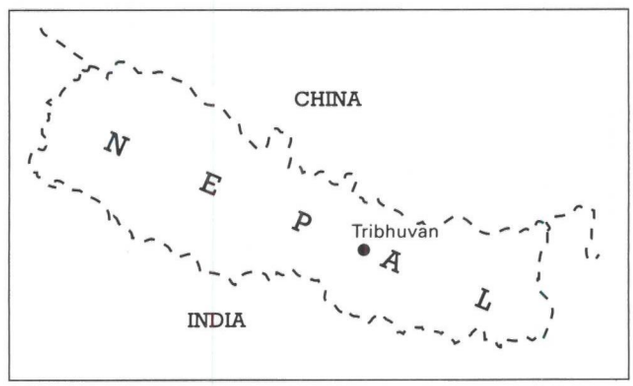
Royal Nepalese Air Force and Royal Flight

Operating from only a single base (Kathmandu/Tribuvan), the Royal Nepalese Air Force has been severely constrained by budgetary considerations, and a long-standing requirement for an attack-capable trainer remains unfulfilled. For many years Nepal's only air arm was the Royal Flight, which operated three Twin Pioneers, two C-47s and a mixed bag of other types, including an Antonov An-2, Ilyushin Il-14M, a Beech Queen Air, a DHC-6 Twin Otter, and an Aérospatiale Alouette III helicopter. These were occasionally used by the Army, which did not have its own aircraft.

Today the Royal Flight continues to operate a small number of aircraft (single examples of the Aérospatiale Alouette III, SA 330G Puma and AS 332 Super Puma), although the Royal Army of Nepal has formed its own Air Corps which gained autonomy in mid-1979. During the early 1970s the Army received three Aérospatiale Alouette IIIs, two Short Skyvans and a single Puma directly, and benefited from the transfer of a Royal Flight DHC-6 Twin Otter, a Short Skyvan, and a BAe 748. Further direct deliveries included a Romania-built Alouette and a further (fifth) Skyvan. Reports that a second Royal Flight Puma has been transferred may be premature, since the flight seems to retain one ordinary Puma. The Army has stated a requirement for three Bell 206L LongRangers. Today the Army's strength seems to comprise three Skyvans (one was lost in December 1985), two Alouette IIIs, and single examples of the BAe 748 and Aérospatiale Puma.

Order of Battle

UNIT	EQUIPMENT	BASE
Air Corps	Short Skyvan 3M/3E, Alouette III/IAR 316, BAe 748-275, SA 330G Puma	Tribhuvan
Royal Flight	Alouette III, AS 332 Super Puma, SA 330C Puma	Tribhuvan



A handful of Soviet-built MiG-21s remain on charge, including this MiG-21UM.

Right: No. 8 Squadron at Chittagong converted to the Nanchang A-5 from the F-6 during 1991.

The surviving MiG-21MFs are believed to remain in use as hacks with No. 5 Squadron at Dhaka.

Below: This trio of Bell 212s (of 10 delivered) serves with No. 31 Squadron at Dhaka in the VIP role.

The dragon's head badge of No. 8 Squadron is worn on the noses of the unit's A-5Cs.

Above: Two An-32 'Clines' were delivered in 1989, replacing An-26s with No. 3 Squadron at Jessore.

Below: The first of five Mil Mi-17s was delivered in 1992 and wears an unusual two-tone green camouflage.

No. 1 Squadron at Chittagong is now relinquishing its Mil Mi-8s in favour of the newer Mi-17.

Below: Royal Nepalese Air Force aircraft wear a six-pointed star, with a trident superimposed.

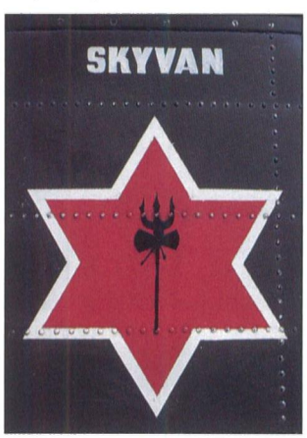
Below: Nepalese Royal Flight aircraft use a more ornate insignia with a star, tridents and a crown.

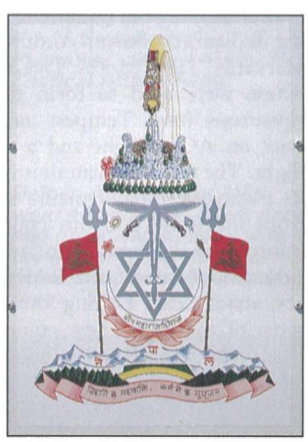
The air force operates a single SA 330 Puma, in drab and Dayglo finish.

Above left: One of two air force Alouette IIIs.

Left: Three of the four Short Skyvans delivered to Nepal remain in service with the air force.

Right: Wearing partial Royal Nepal Airlines colours, this BAe 748 also carries a military serial, and is on air force charge.





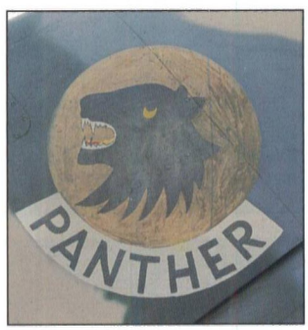
Nepal's second 'ordinary' Puma (an SA 330G) serves with the Royal Flight.

Above: All Nepalese Royal Flight aircraft wear a smart overall white colour scheme with outline red cheatlines. The Royal Flight currently operates a single Alouette III from its base at Tribhuvan.

The Royal Flight's third and most modern aircraft is an AS 332 Super Puma. Royal Flight aircraft wear Nepalese civilian registrations.

Left and below: A small badge below the canopy and a non-standard but dapper colour scheme identify this PAC Mushshak as being something out of the ordinary. No basic trainer, it belongs to the Northern Air Command HQ Flight.

This silver No. 15 Squadron F-6 wears red and white instead of the more normal black and white checkers.



Above: One variant of the panther's head badge is worn by No. 16 Squadron's Nanchang A-5s.

Also based at Peshawar, No. 26 Squadron's A-5s wear this distinctive 'Black Spider' badge.

With underwing fuel tanks and AIM-9P Sidewinder missiles, this No. 26 Squadron A-5C has little capacity for a large offensive warload, the type's main drawback.

Pakistan

Pakistan Fiza'ya/Pakistan Air Force

Sandwiched between Afghanistan and the former USSR to the west and India to the east, Pakistan is much smaller than its neighbours. For this reason, the Pakistan Air Force (PAF) has always had a tremendous importance as a defender and guarantor of the nation's freedom and independence, and has recently received the lion's share of defence funding.

The Pakistan Air Force was formed on 15 August 1947, one day after the country achieved independence from India. The PAF was created by the transfer of 56 aircraft from the Indian Air Force, comprising Tempests, Harvards, Tiger Moths, Dakotas and Austers. These were used to form three operational squadrons (two Tempest and one Dakota), with an AOP Flight and a communications flight. The infant air arm thus inherited most of its traditions, rank structure and organisation from the RAF, and this connection was reinforced by the fact that many of the air arm's first senior officers were RAF men on temporary attachment. During the next few years most of the PAF's new equipment was procured from Britain, including the air arm's first jet fighters, Supermarine Attackers, which arrived in August 1951.

In 1952, impoverished Pakistan turned to the USA for military aid, which promised to allow the procurement of modern equipment at prices Britain's aircraft industry could not match. For the USA, Pakistan promised to be a bulwark against Soviet Communist expansionism and a useful partner in the region. India had already demonstrated its determination to steer a neutral course, and when such 'neutrality' was backed by the purchase of defence equipment from both Britain and the USSR, Pakistan seemed to be a heaven-sent, ready-made ally, and a useful platform from which influence could be exercised.

Pakistan hoped to obtain a wide range of aircraft from the USA, including B-50 Superfortresses (or P2V Neptunes as a second choice) and F-84 Thunderjet fighter-bombers, as well as a huge force of T-33 jet trainers. The latter, it was hoped, would allow Pakistan to rapidly train its own cadre of fast-jet pilots. Observing the level of US aid to nations like Germany, Pakistan assumed that US assistance to a nation committed to countering Soviet and Chinese Communist influence in Asia would be almost unlimited. Thus, in 1954 Pakistan formulated a requirement for a 44-squadron air force, with 10 day-fighter, five night-fighter, five light bomber, one photo recce, 12 fighter-bomber/fighter recce, three transport and two maritime recce squadrons. The aim was to attain numerical and qualitative superiority over India, to offset the advantage India enjoyed at sea and on land. Fortunately for peace in the area, America (in the shape of the US Military Aid Advisory Group) did not want to give Pakistan any overtly offensive capability and envisaged a much smaller force, with only eight front-line combat squadrons (six fighter, one night-fighter and one light bomber).

This initial US aid eventually consisted of 120 F-86F Sabres, 28 or 30 B-57s and between 12 and 20 F-104 Starfighters, in addition to T-33s, C-130s, HH-43s, and HU-16s. Force levels were maintained with attrition replacements until about 1963, when US-Pakistan relations soured after Pakistan formed two extra army divisions using US equipment earmarked as reserve stock. The difficulties inherent in estimating the Pakistan Air Force's establishment begin even with this early batch of deliveries. The official PAF history records the delivery of 12 F-104s, conveniently ignoring at least one ex-CNAF F-104A confirmed as having been delivered, while other reliable sources suggest

These Shenyang F-6s wear the insignia of No. 14 Squadron, which has since become an F-16 squadron.

Below: Based alongside No. 14 at Kamra are the F-6s of No. 15 Squadron, the 'Cobras'.

Above: Pakistan's A-5 units usually have a handful of FT-6 trainers. This one belongs to No. 16 Squadron.

The nose of a No. 16 'Panthers' Squadron A-5 shows the new RWR fitted to some of these aircraft.

No. 16 Squadron's A-5s advertise their ownership with a fin badge and a 'panther' logo on the nose. Most A-5s wear a two-tone brown and green camouflage.

This map of Pakistan shows the major air bases of all three services.

Left: This white-painted Shenyang FT-6 serves with No. 26 Squadron at Peshawar, as part of No. 36 Tactical Attack Wing.

Below: A handful of A-5s wear a handsome sand, grey and green camouflage with the darker of the normal browns replaced by a sea grey.

various higher figures.

The lack of US support did not stop Pakistan going to war against India in 1965, but did result in a post-war US arms embargo against Pakistan. The achievements of the Pakistan Air Force in 1965 have often been overstated, with inflated kill claims and a reluctance to admit true losses. Nevertheless, Pakistan unmistakably won the war in the air, in that it was able to prevent the Indian Air Force from achieving its objectives. The prestige of the Pakistan Air Force was greatly enhanced, and the service was widely regarded as the nation's saviour. It justified its motto of 'Lord of All We Survey' and its self-given appellation as the 'Pride of the Nation'.

Pakistan's relatively small numerical losses represented a substantial percentage of its front-line aircraft strength, however, and the US arms embargo caused an immediate crisis. To build up its air force, Pakistan first turned to China, a natural ally since its 1962 war with India and a nation which had recognised the Pakistani claims to North Kashmir which were the foundation of the 1965 war. China donated 74 Shenyang F-6s (Chinese-built MiG-19s), and provided training for a cadre of pilots. The aircraft were rapidly equipped with AIM-9 Sidewinder missiles. Three squadrons were operational by the end of 1966. Pakistan also purchased 90 ex-Luftwaffe Canadair Sabre Mk 6s, circumventing the US/Western embargo by obtaining them via Iran.

Rounding off Pakistan's re-equipment were 18 Mirage IIIEP fighter bombers, three Mirage IIIDP trainers and a trio of Mirage IIIRP recce aircraft, which were purchased at a cost of some $90 million (nine times the figure paid for the 90 Sabres). A US offer of a one-off arms deal, comprising seven B-57s, eight F-104s and four S-2 Trackers, was rejected because Pakistan was unwilling to pay for the equipment.

War erupted again in 1971, with Pakistan launching pre-emptive air strikes after claiming that India was supporting Bengali separatists in East Pakistan (now Bangladesh). India's retaliatory air attacks were devastating, and the PAF was unable to seriously challenge Indian air superiority during the rest of the brief war, which resulted in the independence of East Pakistan as Bangladesh. Interestingly, the PAF was augmented during the war by No. 9 Squadron of the Royal Jordanian Air Force, flying F-104s, and by the delivery of between 20 and 75 F-86s from Saudi Arabia. It is also believed that Libya sent a training detachment of five F-5s, perhaps to allow for rapid transfer of more of these aircraft had the war gone on for a longer period. On the other hand, Pakistan was severely handicapped by its need to dismiss some 4,000 Bengali pilots and ground personnel, who could no longer be relied upon. Exact kill and loss figures remain controversial to this day, but it is clear that India effectively won the air war in 1971, and that the Pakistan Air Force emerged with a dented reputation and was blamed by the man in the street for 'letting down the nation'.

After the 1971 war, Pakistan again turned to China, purchasing two batches of 60 F-6s in 1972 and 1977. This allowed the retirement of the obsolete Sabre, the final two squadrons disbanding in 1980. Shenyang FT-5s (Chinese-built two-seat trainer derivatives of the MiG-17) were delivered from 1975 for advanced flying training and conversion/continuation training for F-6 pilots, replacing the handful of FT-2s (Chinese-built MiG-15UTIs) delivered with the first F-6s. Two-seat FT-6s were not delivered until September 1980, allowing the FT-5s to be used exclusively for advanced pilot training. A rebuild/overhaul facility was established at Kamra for the frequent overhauls required (every 600 flying hours). This built up to a capacity of overhauling more than 30 F-6s and FT-5s per annum, and manufacturing 7,000 commonly required spare parts. Some reports suggest that a handful of F-104s were procured from Belgium, but this seems extremely unlikely and, in any event, the Starfighter's days were numbered after their heavy losses in the war.

While the F-6 allowed the PAF to rebuild and even expand its numerical strength, the air force was determined to procure high-quality modern Western aircraft as well. Even before the war, Pakistan had ordered 28 (some say 33) Mirage 5PAs and two twin-stick Mirage 5DPs to augment the original 24 Mirages, and new orders were subsequently placed for an eventual total of 10 Mirage IIIRPs, 30 Mirage 5PA2/3s and two Mirage 5DPAs, raising total PAF Mirage procurement to 96. (Some sources suggest a higher total, with 13 Mirage IIIRPs, 30 Mirage 5PA2/3s and four Mirage 5DPAs.) It has been suggested that these were later augmented by some 10 ex-Lebanese and eight ex-French Mirages. These were used primarily in the fighter-bomber role, augmenting the surviving B-57s, which became progressively less credible as time passed. Pakistan's Mirages can all be equipped with SEPR 844 rocket packs to improve hot-and-high take-off or high-level dogfighting performance. Weapons in use include the Durandal runway-cratering bomb, the AM39 Exocet and MATRA R530 and 550 air-to-air missiles.

Had relations with the US been easier in the mid-1970s, the Mirages might have been used more in the air-to-air role, since in 1976 the US government offered to sell 110 new A-7 Corsairs (funded by Saudi Arabia), conditional on Pakistan abandoning plans to buy a French nuclear reprocessing plant. Prime Minister Bhutto refused these conditions, and the A-7 offer was withdrawn by US President Jimmy Carter, who also managed to halt the French nuclear plant sale to Pakistan.

In a second effort to influence Pakistan to place its nuclear programme under international control, Carter offered Pakistan 110 Northrop F-5Es, but the offer was rejected by the new head of state, General Zia. Relations between the two nations worsened, with Pakistan withdrawing from SEATO and CENTO and with the US Embassy in Islamabad being burned down.

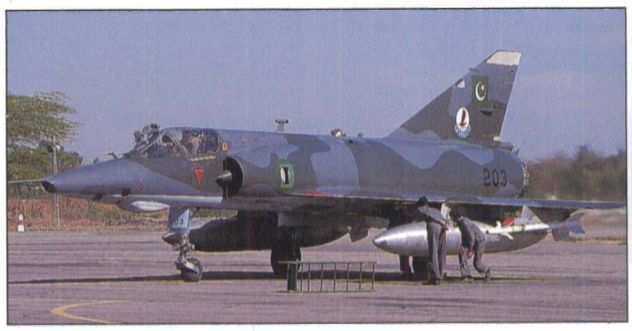
Pakistan has always been able to rely on significant levels of support from various Moslem states, and from the 1970s industriously worked at fostering stronger ties with such allies. Pakistani pilots were posted as advisers and instructors to Jordan, Egypt, Libya, Iran, Saudi Arabia, Oman and the United Arab Emirates. In time of war, they would have returned to Pakistan, often with the host country's aircraft,

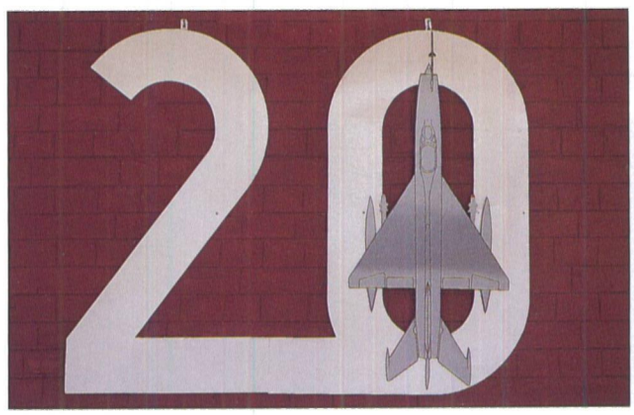
Shenyang FT-5s (Chinese-built two-seat derivatives of the MiG-17) serve as advanced trainers.

Below: No. 25 Squadron operates this ex-No. 20 Squadron F-6 in its old markings.

No. 25 Squadron acts as the OCU for the Shenyang F-6, on which most PAF fast jet pilots cut their teeth.

Below: One of Pakistan's Mirage IIIRP reconnaissance aircraft (13 were delivered) serves with No. 5 Squadron.





No. 20 Squadron's crew-room is embellished with a huge representation of a Chengdu F-7P and the squadron number.

The flying suit badge worn by No. 19 Squadron pilots.

Below: This No. 19 Squadron F-6 carries an unusual faired-in underbelly fuel tank and wears an elegant all-white colour scheme.

The F-6 remains a useful multi-role fighter, though deficient in range. This No. 19 Squadron aircraft carries underwing rockets.

Right: No. 19 Squadron formed in 1991 as the F-7P OCU, before renumbering as No. 25 Squadron in July 1991.

Below: This F-6 is from No. 25 Squadron, the F-6 OCU until its number was taken over by the F-7P OCU, when it became the new No. 19 Squadron.

This is one of No. 5 Squadron's Mirage IIIEPs. During their long service lives, these aircraft have received much new equipment, including prominent RWRs on the spine and canopy frame.

Below: A No. 20 Squadron Chengdu F-7P is armed with underwing AIM-9P Sidewinder air-to-air missiles. Pakistan's F-7Ps are finished in a rather chic two-tone pale grey air-superiority camouflage.

No. 5 Squadron's crew-room is decorated with the squadron nickname and a Mirage-shaped sign.

Below: One of No. 20 Squadron's Guizhou FT-7s, which operate alongside single-seat F-7Ps.

to defend the homeland.

The Soviet invasion of Afghanistan in December 1979 initially had little effect on US policy towards Pakistan, but after Ronald Reagan became president Pakistan was granted a $1.6 billion loan against arms purchases. Pakistan also received a longer-term, low-interest $500 million loan from Saudi Arabia. The sum of $750 million went on the purchase of 40 General Dynamics F-16s (including 12 F-16B two-seat trainers), which were delivered between 1983 and 1986. To speed things up, six aircraft came from existing production earmarked for NATO allies. The USA initially pressed Pakistan to accept the F-16/79 (or even the F-5G Tigershark), with ALR-46 RHAW gear, but the PAF held out for full standard F-16As with the more effective ALR-69, having initially hoped to purchase F-15s or F/A-18s, both of which were too expensive and barred by the US government. In return, the US government gained an ally which was tireless in its support for the Afghan Mujahideen, exposing itself to Soviet retaliation.

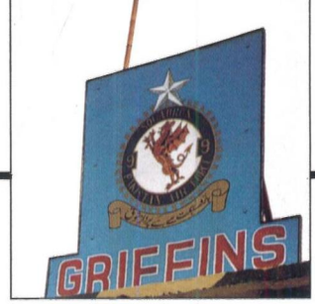
In view of the influence that the Soviet invasion of Afghanistan had on allowing Pakistan its F-16s, it is perhaps appropriate enough that the aircraft has been used in anger against Russian and Afghan aircraft violating Pakistani airspace and sometimes bombing or strafing guerrilla bases. PAF F-16s have downed three Su-22s, an Su-25, two MiG-23s and an An-26, and claimed another Su-22 as a 'probable'. In an unfortunate incident in April 1987, it appears that a Pakistani F-16 pilot also shot down his own wingman (who ejected safely) during an engagement with six Afghan aircraft. In 1988 a further 11 aircraft were delivered, allowing the formation of a third squadron. This was still a long way short of Pakistan's declared intention of having five F-16 squadrons, and delivery of the 60 extra PW-220-engined F-16As and 11 F-16Bs ordered in 1989 now looks doubtful. Although the F-16 squadrons are the PAF's most capable interceptors, they retain a significant ground attack capability, enhanced by the provision of French ATLIS laser designators for use with laser-guided bombs or AS30L air-to-surface missiles.

Even had the PAF taken delivery of every F-16 it could afford, there was still a need for cheaper fighters and ground attack aircraft to make up numbers. Fortunately Pakistan had maintained its contacts with China, and in 1983 began receiving the Nanchang A-5C, a dedicated ground attack derivative of the F-6. An initial batch of 90 aircraft was ordered, but a second batch of 90 was cancelled, and one of three A-5C squadrons was briefly inactivated while its aircraft were overhauled in China. Some sources suggest that only 52 A-5Cs were ever delivered, and even that this was the extent of the original order. Pakistan maintains an interest in the Aeritalia-upgraded A-5M (which features what is virtually an AMX all-weather avionics suite) and has established a Q-5 overhaul and rebuild facility at Kamra, which has a capacity of between 10 and 25 A-5 rebuilds per annum. The A-5 has a relatively long airframe life by Chinese standards (1,800 hours) and requires two major overhauls (each lasting some eight months) during this time. Further procurement of the basic A-5C, however, seems unlikely, since the F-7P seems to offer almost the same ground attack capability with better performance and agility and with genuine potential in the intercept role.

The need for a new 'cheap' fighter was urgent, since many F-6s had run out of hours, and others were going through the third of their three 600-hour overhauls at Kamra. In any case, the F-6 was beginning to show its age, despite a programme of upgrades which included the installation of new avionics, Martin Baker ejection seats and AIM-9 Sidewinders. Its natural replacement was the F-6's successor in Chinese service, the Chengdu J-7. The J-7 is basically an unlicensed copy of the original MiG-21F-13 'Fishbed-C', albeit with a handful of significant improvements. The F-7M Airguard was a further improved variant for export to customers used to Western aircraft, and the Pakistani version, known as the F-7P Skybolt, is based on the Airguard, with further improvements. The two-piece canopy of the F-7M and F-7P has increased birdstrike resistance, and covers a GEC Avionics HUDWAC (Head-Up Display and Weapons Aiming Computer), and various new avionics. Two extra underwing hardpoints are provided, and there are a host of other improvements. The most important F-7P improvements are a Martin Baker 10L zero-zero ejection seat, and provision for up to four AIM-9 Sidewinders.

The Pakistan Air Force had long had an interest in the MiG-21, since many of its pilots had flown the aircraft while on exchange tours with Arab air arms (and one, Air Commodore Sattar Alvi, shot down an Israeli Mirage III in a Syrian MiG-21). The MiG-21 was also a long-term adversary in Indian hands, and had clearly performed well in the 1971 war. The availability of a new version with Western avionics and missiles seemed to overcome the weaknesses of the original aircraft, though it remained inexpensive enough to be a useful low-cost, rapid-reacting, short-range interceptor to augment the more capable and more expensive F-16. Pakistan therefore placed an order for 20 F-7Ps in 1985, and these were delivered to No. 20 Squadron from July 1988. A second batch of 60 slightly improved F-7PMs, with a new cockpit layout, Collins AN/ARN-147 VOR/ILS and AN/ARN-149 ADF and Pro Line II digital ADF were delivered from 1989. In Pakistani service the F-7PMs are known simply as F-7Ps. This batch was accompanied by 15 Guizhou FT-7 two-seat trainers, and delivery allowed three more squadrons to re-equip. The 13,450-lb st (59.8-kN) Wopen WP7B(BM) engine of the F-7P gives it a thrust to weight ratio similar to that of the heavier MiG-21bis, but the lighter airframe gives a lower wing loading, which is said to be even lower than that of the F-16.

At one time, Pakistan had hoped to procure the Chengdu/Grumman Sabre 2, an Airguard derivative with new avionics and a new Western engine (the PW 1120, GE F404 and Turbo Union RB199 were all mooted), with a solid radar nose and side-mounted air intakes. This would have given a modern high-performance fighter at a very low cost. The project was effectively killed by the breakdown in US/Chinese relations following the massacre at Tienanmen Square. It was superseded by the



The squadron badges of No. 9 (above) and No. 11 (left) Squadrons, both F-16 units within No. 38 Multi-Role Wing at Sargodha, are not carried by the aircraft themselves.

The Special Duties Falcon 20s of No. 24 Squadron carry this badge and 'Blinders' logo.

Below: No. 82 Squadron uses a pair of Alouette IIIs for SAR and utility duties at Sargodha.

This No. 7 Squadron pilot wears an A-5C patch and the 'Bandits' insignia of his squadron, which acts as the A-5 OCU.

No. 2 (Composite) Squadron's B Flight uses this badge on the tailfins of their Lockheed T-33s and RT-33s.

No. 7 Squadron at Masroor acts as the OCU for the Nanchang A-5C 'Fantan'. The use of Chinese aircraft allows Pakistan to operate larger numbers.

Left: This F-16 carries a French ATLIS laser designator and US laser-guided bombs.

No. 2 Squadron's A Flight operates the Chengdu F-7P from Masroor. Many have toned-down insignia.

Below: No. 2 Squadron's T-Birds include a number of RT-33s, distinguishable by their camera noses.

One of No. 11 Squadron's F-16Bs lands at Sargodha.

Below: The A-5Cs of No. 7 Squadron wear this badge, which consists of an Islamic sword, bolts of lightning and seven stars.

A pair of General Dynamics F-16s on patrol from Sargodha. The aircraft of Nos 9 and 11 Squadrons do not wear distinctive squadron markings.

Below: This gaudily-decorated No. 2 (Composite) Squadron T-33 was delivered in 1955, but is still going strong as a target tug and mount for refresher training.

Left: No. 8 Squadron operates Exocet-compatible Mirage 5PA3s from Masroor in the anti-shipping role.

Above: Co-located at Masroor is No. 22 Squadron, the Mirage OCU, which operates this Mirage IIIDP.

Super 7, which substituted European avionics for American, and introduced a non-American engine and various aerodynamic refinements. China has repeatedly offered Pakistan a share in the development programme (which would be an excellent boost for Pakistan's infant aircraft industry), but procurement of more F-7Ps seems more likely. The Kamra overhaul plant has already begun F-7P overhauls.

Most fighter and fighter ground attack squadrons maintain a handful of appropriate trainers. The F-6 and A-5-III squadrons, for example, usually have a couple of FT-6s, while the F-7P units each have a handful of Guizhou FT-7s. The OCUs have a higher proportion of 'twin-stickers' on strength.

The free flow of US aid to Pakistan, including the delivery of further F-16s, F-16 spares and of P-3 Orions already painted in Pakistani colours, has been halted by the Pressler amendment to the Foreign Assistance Act, which bans military assistance to countries believed to be developing nuclear weapons. This is similar to the late 1970s Symington amendment to the same act, which limited the scope and scale of US assistance during the early 1980s. Pakistan's persistent refusal to sign international nuclear non-proliferation agreements, and a body of evidence pointing to nuclear co-operation with China, places it firmly in the frame. Deliveries were accordingly suspended on 1 October 1990. This has reportedly left the F-16 fleet largely non-operational.

The suspension of US aircraft and armaments deliveries represents a major obstacle to the PAF's re-equipment plans, with the hoped-for five-squadron F-16 force still a distant dream. An interim solution to the PAF's perceived 'fighter shortage' was solved earlier in 1990, when Pakistan finalised orders for 50 ex-RAAF Mirage IIIOs, and a comprehensive package of spares including no less than 45 extra engines. Although some reports maintained that the aircraft were virtually at the end of their fatigue lives and had been bought purely as a spares source, it is now believed that the PAF is refurbishing 36 of the aircraft, at a rate of two per month, to allow them to serve for another 10 years and to re-equip one or two F-6 units. Other solutions to the fighter shortage could include a Mirage 2000 or Sukhoi Su-27 buy, both of which have already been discussed by Islamabad.

Fantastic rumours abound that Pakistan actually already operates the Mirage 2000 clandestinely, and that its force of these aircraft could be supplemented in wartime by aircraft borrowed from Abu Dhabi. The Indian aerospace magazine *Vayu* reported that the Bank of Credit and Commerce International (BCCI) allegedly operated as a multi-national arms sales organisation, often on behalf of Pakistan. BCCI reportedly brokered the delivery of 12 Mirage 2000s to Peru, and it is alleged that these aircraft were then transferred to Pakistan, in another deal funded through BCCI. Since photos have never emerged of Mirage 2000s in Peruvian service, and the aircraft have never been publicly seen in Peru, it would seem that the rumour is groundless, most likely invented by India as a scare story to justify an Indian Air Force fighter order.

Most major PAF airfields have a based Alouette III unit (usually with a pair of helicopters) for SAR, liaison and transport duties. These aircraft have entirely supplanted the historic Kaman HH-43B Huskies previously in use. Airfields also have a balloon squadron for 'passive defence', using some 50 jeep-tethered balloons flying at heights up to 3,000 ft (915 m), and intended to make life difficult for the pilots of low-level attack aircraft. The balloons are some 24 ft (7.3 m) long and 9 ft (2.7 m) in diameter. More active air defence is left in the hands of gun batteries (using 14.7-mm, 20-mm and 40-mm cannnon) and Crotale 2000, 3000 and 4000 SAMs. A handful of Chinese HQ-2B long-range high-altitude SAMs (based on the SA-2 'Guideline') are also in service.

Like Pakistan's manned fighters, the SAMs are linked into a sophisticated Air Defence Ground Environment System (ADGES) developed from 1977 by Hughes to give the Pakistan Air Defence Command, formed in 1975, the necessary integrated equipment for early warning, command and control, and to monitor, control and co-ordinate Pakistan's airspace. The underground HQ at Chaklala is linked to four Sector Operations Centres at Peshawar (Northern SOC), Quetta (Western SOC), Sargodha (Central SOC), and Karachi (Southern SOC). Seven reporting centres are subordinate to these SOCs. The backbone of the ADGES is provided by six TPS-43G radars, which are transportable by truck, helicopter or Hercules, and which can be reassembled by a six-man team in less than one hour. They have a high-level range of 400 km (248 miles). Other long-range radar systems include FPS-89/100 radars at Sakesar and Badin, Chinese Type 514s at Skardu and Gilgit, and UK-built Condor radars. The civilian Thomson-CSF ATC radars at Jiwani, Karachi, Lahore, Pasni, Rachim Yar Khan and Rawalpindi are netted into the ADGES. Low-level radar cover is provided by six Plessey AR-1s and three mobile AR-15s, and by 45 Siemens mobile pulse-Doppler radars, controlled by six Control and Reporting Centres or Wings.

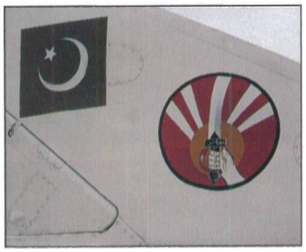
Pakistan has identified a need for an airborne early warning and control system, and its preferred solution is the Boeing E-3 Sentry. At one time the USA was willing to supply Grumman E-2C Hawkeyes, but Pakistan rejected these as being incapable of operating in the high-clutter environment posed in Pakistan's mountainous regions. The Soviet withdrawal from Afghanistan and the Pressler amendment effectively killed off the US offer before Pakistan could reconsider. Some observers believe that Pakistan might obtain a cheaper system based on Aerostat tethered helium balloons.

With a front-line strength of 16 squadrons, and some 300 combat aircraft, Pakistan has a continuing need for a large number of pilots. In fact, with the high proportion of pilots sent overseas as advisers, and the policy of rapid promotion and early retirement, Pakistan actually trains more pilots than many equivalent air forces (the same number of fighter pilots as the much larger Indian Air Force, for example).

Pakistan Air Force pilots begin their training with a four-year BSc course at the PAF College at Risalpur, before a 14-month course at the co-

Above: A No. 22 Squadron Mirage 5PA2. The 5PA2, which has Cyrano IV radar, lacks the Exocet compatibility of the 5PA3.

The Combat Commander's School has separate flightlines for its different types.



The badge of the Combat Commander's School is worn on the fin of this F-6.

Below: This grey and green camouflaged Hercules is one of Pakistan's long-serving ex-USAF C-130Bs.

Many of Pakistan's Hercules, including this ex-Iranian C-130B, have a natural metal finish.

Below: This Fokker F27 serves with No. 12 Squadron in the transport and calibration roles.

The badge of No. 22 Sqn, the Masroor-based Mirage OCU, consists of reversed '2s' in the shape of a Mirage.

The small ranging radar identifies this aircraft as a Mirage 5PA. It serves with No. 22 Squadron.

Right: A Dolphin badge is worn by the Alouette IIIs of No. 84 Squadron, a SAR and utility helicopter unit.

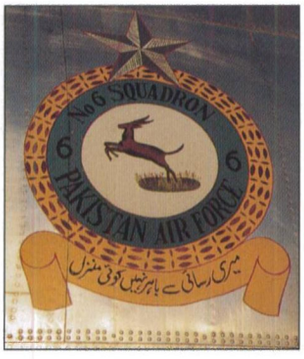
The Combat Commander's School, a lodger unit at Sargodha, includes a handful of Mirage 5PAs.

Below: This Combat Commander's School Shenyang F-6 wears a stylish white colour scheme.

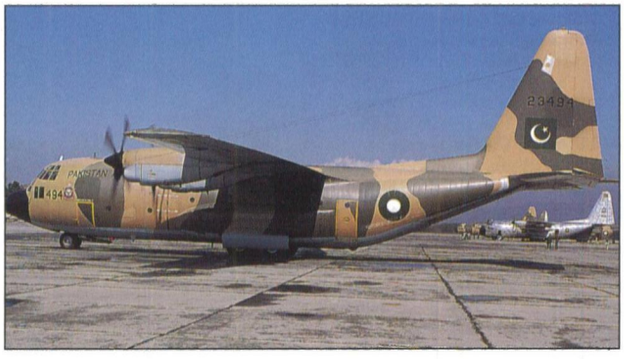
Above: As well as its own Mirage 5PAs and F-6s, the CCS frequently borrows other aircraft, including F-16s.

Right: This Beech King Air 200 serves as a VIP transport with No. 12 Squadron at Chaklala.

Below: This is one of two (or perhaps three) Boeing 707s used by the Pakistan air force for long-range transport duties.



The badge of No. 6 Squadron is applied to one of the unit's C-130 Hercules transports.



Pakistan's C-130s all serve with the Chaklala-based No. 6 Squadron in the transport role.

Two of No. 12 Squadron's Boeing 707s.

Left: A single Falcon 20E operates in the VIP role with No. 12 Squadron.

located Air University. Recreational flying is available to cadets, using a handful of Scheibe SF-25C Falke self-launching motor gliders. At Risalpur the cadets undergo a 14-week primary training stage involving 44 hours on the Mushshak, and then a 38 to 45-week, 120-hour basic flying training course on the Cessna T-37. Thirty-seven T-37Cs were obtained as part of the US Military Aid Program, six more T-37Bs following from surplus USAF stocks, and 22 being leased since 1976 (16 aircraft) and 1980 (six aircraft). None of the latter 22 have been returned, but only about 28 T-37Bs and 25 T-37Cs survive. Two T-37s are used by Air University instructors for the 'Sherdils' ('Lionhearts') aerobatic team. The T-33 has now been retired from the pilot training role, though 10 serve with No. 2 Squadron for refresher training and target facilities. After the award of wings, today's student pilots go from the Academy to No. 1 Fighter Conversion Unit for a 60-hour/90-sortie course on the Shenyang FT-5. The T-37 and FT-5 are to be replaced by a turboprop trainer, and by the Karakoram K-8, a Sino-Pakistani tandem-seat advanced jet trainer which first flew in November 1990. An initial batch of 25 is reported to be on order.

Streaming for fast jet, helicopter and transport aircraft follows the FT-5 fighter course. Fighter pilots undergo a 60-hour course on the FT-6/F-6, FT-6/A-5 or FT-7/F-7P with No. 19 or No. 25 Squadron, before being posted to an A-5, F-6 or F-7P squadron. Conversion to the Mirage is only possible after at least six months' service on the F-6 or F-7, and F-16 pilots are similarly drawn from more experienced aircrew. Fighter leaders (flight or squadron commanders) and fighter weapons instructors undergo training on the F-6, F-7P or Mirage at the Combat Commander's School at Sargodha, which runs a four-month 50-sortie course, as well as providing aggressor aircraft for exercises.

The PAF has concentrated its efforts and resources largely on the front line and training for the front line, and has relatively few support and second-line aircraft. The Pakistan Army is easily supplied by road and rail, with only four of its 80 brigades stationed in the mountainous northern area. In time of war, in any case, airlift capacity would be swelled by the loan of C-130s from Arab allies such as Iran, Saudi Arabia, Egypt and Turkey. Three existing transport squadrons fly the 11 or 12 survivors of 20 C-130Bs, C-130Es and L-100s obtained from various sources. These are understood to have been upgraded in Singapore during 1990-92. A pair of Antonov An-26s which defected from Afghanistan in 1988 has now been retired, and other transport aircraft on charge include two or three Boeing 707-340Cs, one or two Beech Barons and single examples of the Dassault Falcon 20E, Fokker Friendship (used for navaid calibration), King Air, Rockwell Commander and Piper Seneca. A Beech Travel Air and a Twin Bonanza are believed to have been withdrawn.

Some reports suggest that six Chinese Y-12 transports may be on order to replace the various light transport types, bringing simplified maintenance requirements and greater flexibility and capacity. No. 24 Squadron at Sargodha (dormant since 1968) reformed in 1987 with a pair of Dassault Falcon 20Fs equipped for what the PAF has described as 'special duties'. Two Falcon 20Gs were modified for the squadron by Aeritalia at the Italian navy's Venice facility in 1987-88. The aircraft are believed to fulfil an ECM training and Elint function. Indian reports that some of the small twin Beech transports may have been adapted for EW/Elint duties seem unlikely.

Helicopters are available in even smaller numbers, the Army having the main responsibility for rotorcraft. Apart from the Alouette IIIs used for SAR, the PAF has an unfulfilled requirement for a medium-lift transport and utility helicopter. A single Mi-6 was operated by the PAF between 1968 and 1969 (when it crashed) and 10 CH-47s were loaned by Iran during the early 1970s. Four Super Frelons were reportedly ordered from France in 1975, but were never delivered.

Just as India uses a network of FBSUs, Pakistan is building up a similar pattern of reserve airfields, equipped for operations by front-line squadrons. Former emergency strips at Multan, Sukkur and Jacobabad have been extended and upgraded, and a reported 32 airfields have been or are being built or upgraded in Baluchistan, including several funded by the USA. Among these are Gwadar, Jiwani, Mount Rascoh, Panjguar, Pasni and Turbat. Another airfield is being constructed near Hyderabad. Existing airfields with no known based units include Chanderi, Kohat, Lahore, Malir, Multan and Risalewala.

Secrecy is almost as endemic in Pakistan as it is in India, so the following order of battle must be regarded as provisional and partial. The locations of seven maintenance units and other major non-flying units remains unknown.

Order of Battle

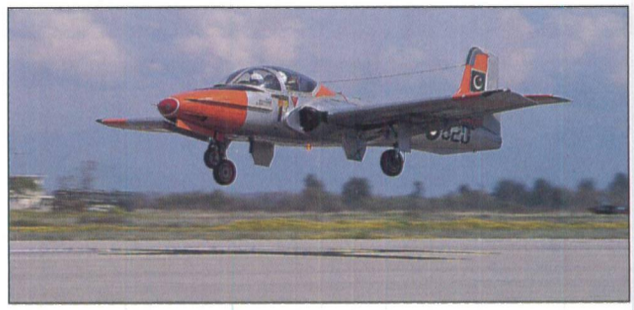
UNIT	EQUIPMENT	BASE
Northern Air Command, HQ Peshawar		
Northern Air Command HQ Flight	PAC/MFI-17 Mushshak	Peshawar
No. 33 (Fighter/Multi-role) Wing, Kamra		
No. 14 Sqn 'Fighting 14/Shaheens'	General Dynamics F-16A/B	Kamra
No. 15 Sqn 'Cobras'	Shenyang F-6, FT-6	Kamra
Station Flight	PAC/MFI-17 Mushshak	Kamra
No. 36 (Tactical Attack) Wing, Peshawar		
No. 16 Sqn 'Panthers'	Nanchang A-5C, Shenyang FT-6	Peshawar
No. 26 Sqn 'Black Spiders'	Nanchang A-5C, Shenyang FT-6	Peshawar
No. 81 Sqn	Alouette III	Peshawar
No. 37 (Combat Training) Wing, Mianwali		
No. 1 Fighter Conversion Unit	Shenyang FT-5	Mianwali
No. 19 (OCU) Sqn 'War Hawks/ Sherdils'	Shenyang F-6, FT-6	Mianwali
No. 25 (OCU) Sqn 'Eagles'	Chengdu F-7P Skybolt, Guizhou FT-7	Mianwali
No. 86 Sqn	Alouette III	Mianwali
Station Flight	PAC/MFI-17 Mushshak	Mianwali
Central Air Command, HQ Sargodha		
Central Air Command HQ Flight	PAC/MFI-17 Mushshak	Sargodha
No. 34 (Fighter) Wing, Rafiqi		
No. 5 Sqn	Dassault Mirage IIIEP, Mirage IIIRP/IIIRDP	Rafiqi
No. 18 Sqn	Chengdu F-7P Skybolt, Guizhou FT-7	Rafiqi
No. 20 Sqn 'Cheetahs/Eagles'	Chengdu F-7P Skybolt, Guizhou FT-7	Rafiqi

This Alouette III wears a business-like new two-tone camouflage, and is fitted with engine filters.

Below: The Cessna 172 is in use in the liaison role with No. 41 Squadron at Chaklala.

The Pakistan Air Force operated a single ex-Afghan Antonov An-26 (which defected) until recently.

Below: The Cessna T-37 serves with two preliminary flying training squadrons of the PAF Academy.



One of the few aircraft types operated by both India and the Pakistan Army is the Mil Mi-8.

No. 41's liaison aircraft wear a simple badge on their tailfins.

Right: The Piper Seneca II is another type in use with No. 41 Squadron for liaison and light transport duties.

No. 41 Squadron's disparate fleet of light aircraft wear a variety of simple colour schemes.

Below: This Beechcraft Baron B55 is on charge with No. 41 Squadron, but other Beech twins have retired.

A PAC Mushshak and a Cessna T-37 fly in formation, examples of the standard PAF trainers.

Below: T-37s from the PAF Academy at Risalpur are decorated with differently coloured noses.

Above: A line-up of PAC MFI-17 Mushshaks wears a fashionable black and Dayglo paint job.

The 'Sherdils' aerobatic team are full-time instructors who fly Cessna T-37s from the PAF Academy at Risalpur.

The much-prized 'Sherdils' flying suit patch marks out its owner as one of the PAF's most skilled pilots.

Below: This Cessna O-1 was one of the first in Pakistan Army service, and now flies with No. 13 Squadron.

This PAC MFI-17 Mushshak serves with the Army's No. 13 Squadron alongside Cessna O-1s.

No. 83 Sqn	Alouette III	Rafiqi
No. 456 Sqn	Crotale SAM	Kahuta?
No. 38 (Multi-role) Wing, Sargodha		
No. 9 Sqn 'Griffins'	General Dynamics F-16A/B	Sargodha
No. 11 (OCU) Sqn 'Arrows'	General Dynamics F-16A/B	Sargodha
No. 24 Sqn 'Blinders'	Dassault Falcon 20	Sargodha
No. 82 Sqn	Alouette III	Sargodha
No. 451 Sqn	Crotale SAM	Sargodha
Southern Air Command, HQ Faisal		
Southern Air Command HQ Flight	Aero Commander 680	Faisal
No. 31 (Fighter) Wing, Samungli		
No. 17 Sqn 'Tigers'	Shenyang F-6, FT-6	Samungli
No. 23 Sqn	Shenyang F-6, FT-6	Samungli
No. 85 Sqn	Alouette III	Samungli
No. 454 Sqn	Crotale SAM	Samungli
No. 32 (Fighter Ground Attack) Wing, Masroor		
No. 2 Sqn (A Flight)	Chengdu F-7P Skybolt	Masroor
No. 2 Sqn (B Flight)	Lockheed T/RT-33	Masroor
No. 7 (OCU) Sqn 'Bandits'	Nanchang A-5-III, Shenyang FT-6	Masroor
No. 8 Sqn	Dassault Mirage 5PA3	Masroor
No. 22 (OCU) Sqn	Dassault Mirage 5PA, IIIDP, 5PA2, 5DP, 5DPA2	Masroor
No. 84 Sqn 'Dolphins'	Alouette III	Masroor
No. 453 Sqn	Crotale SAM	Masroor
Unknown squadron	HQ-2B SAM	Masroor
Independent/direct reporting units		
Combat Commander's School	Shenyang F-6, Mirage 5PA	Sargodha
No. 35 (Composite Air Transport) Wing, Chaklala		
No. 6 Sqn 'Antelopes'	Lockheed C-130B/E, L-100 Hercules	Chaklala
No. 12 Sqn	Fokker F27, Dassault Falcon 20, Beech King Air 200, Boeing 707-340C	Chaklala
No. 41 Sqn	Cessna 172, Piper Seneca, Beech Baron	Chaklala
Transport Conversion School	C-130s (borrowed)	Chaklala
No. 455 Sqn	Crotale SAM	Chaklala
Unknown squadron	HQ-2B SAM	Chaklala
PAF Academy/Air University, Risalpur		
Primary Flying Training Wing		
No. 1 Preliminary Flying Training Sqn	PAC/MFI-17 Mushshak	Risalpur
No. 2 Preliminary Flying Training Sqn	PAC/MFI-17 Mushshak	Risalpur
Basic Flying Training Wing		
No. 1 Basic Flying Training Sqn	Cessna T-37B/C	Risalpur
No. 2 Basic Flying Training Sqn	Cessna T-37B/C	Risalpur
Flying Instructors' School	PAC/MFI-17 Mushshak	Risalpur
(also uses Cessna T-37 and Shenyang FT-5 on an *ad hoc* basis)		
Pakistan Air Force College, Risalpur		
	Scheibe SF-25 Falke	Risalpur
No. 101 Maintenance Unit	Engine overhauls	Sharea
No. 102 Maintenance Unit	Aircraft storage	Faisal

Pakistan Army Aviation Corps

The Pakistan Army is dominated by highly professional Sandhurst-trained officers, and has always been the most important of the country's three armed services. It retains much of the tradition and élan of the old British Indian Army, but has also embraced a new indigenous, Islamic and professional image. Twenty-four of the 45 years since independence have been under military rule, and three of seven army chiefs of staff have served as President.

Taking a massive 70 per cent of the country's defence budget, the Army consists of nine corps, headquartered at Bahawalpur (XXXI Corps), Gujranwala (XXX Corps), Karachi (V Corps), Lahore (IV Corps), Magla (I Corps), Multan (II Corps), Peshawar (XI Corps), Quetta (XII Corps), and Rawalpindi (X Corps). These control 21 divisions, two of them armoured, with eight infantry and two armoured divisions in reserve. The Army is well trained, and has been to war with India in 1947, 1965 and 1971, and in skirmishes in 1987 (over the disputed Siachen glacier). The Army has also been used to contain and put down internal unrest, in Bangladesh during 1971, in Baluchistan during the mid-1970s, and currently in Sind. The Army presently has a policy of 'offensive defence' whereby it would launch a major strategic offensive if threatened, rather than waiting to be attacked.

When the PAF was formed in August 1947 it incorporated an Auster-equipped Air Observation Post Flight, which gained autonomy in 1958, and achieved full corps status in 1977. The four original Auster Mk 5s and seven Mk 6s were augmented over the years by an eventual total of 46 similar aircraft, plus 17 Auster J/5F Aiglets for training. In 1957 around 60 Cessna O-1 Bird Dogs were delivered as part of the then-current US aid programme, and these replaced most of the Austers, forming two front-line AOP Squadrons. Further O-1s were later assembled at the Army's 503 Workshop at Dhamial, eventually with 60 per cent indigenously-manufactured components. The formation of these units was part of a wider reorganisation in which the Army took over responsibility for maintaining its own aircraft. Army pilots began training in the USA, and an Army Aviation School opened for business in January 1959. Eighteen Bell 47/OH-13s were obtained from the USA in 1964, after a cadre of helicopter pilots had been trained in the USA. The delivery of these aircraft allowed several composite squadrons to form, equipped with a mix of helicopters and fixed-wing aircraft. These were 'blooded' in the 1965 war, flying liaison, spotting and FAC sorties.

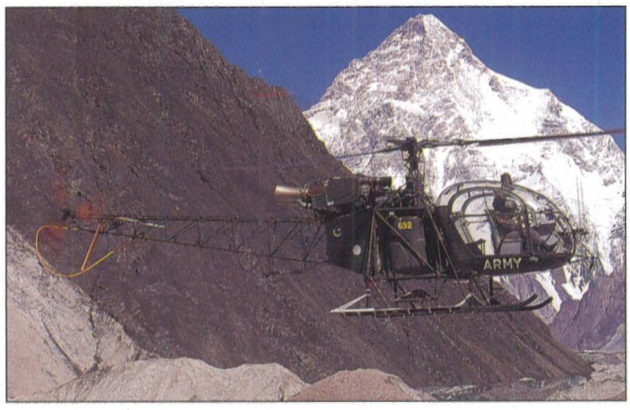
The war brought an abrupt end to US aid, and the Army turned to France for its next helicopter, in the form of the Aérospatiale Alouette III. An initial batch of 24 was delivered, some of them in knocked-down form for assembly by the Army. These have since been augmented by further Alouette deliveries, including four from CNIAR in 1983, and six Romanian-built SA 315B Lamas (up-engined Alouette IIs) in 1987. The latter are used for high-altitude work, and have been involved in the operations in the Karakoram mountains and the Siachen glacier.

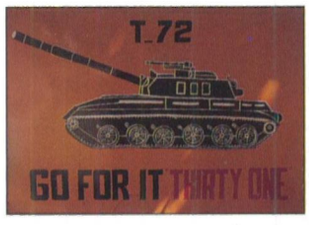
Medium-lift capability was added in 1969, with the procurement of 12 Mil Mi-8 'Hips', an aircraft much prized for its external cargo hook and large clamshell doors. Spares shortages grounded the aircraft for some years, but links with China provided an alternative source of parts and operations were fully resumed in the late 1980s. The Mil Mi-8 and Alouette III saw service during the 1971 war, operating in East Pakistan and being evacuated via Burma after the ceasefire. During the war, many civil aircraft, including DHC-2 Beavers and Cessna 172s, were pressed into service wearing desert camouflage and military markings.

Immediately before the war Mil Mi-8s and Alouettes had been used in rescue and disaster relief operations following the disastrous floods in East Pakistan. US concern about future natural disasters prompted the 1973 gift of six UH-1Hs, with the strict proviso that these should be used only for humanitarian work.

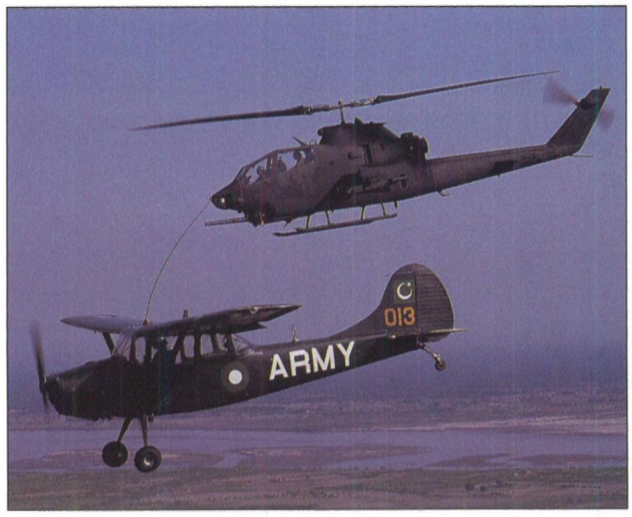
Left: The Army's No. 8 Squadron operates all Army Lamas from Dhamial and Skardu.

Below: The Skardu detachment supports army operations in the Siachen glacier area.





Two signs outside No. 31 Squadron's accommodation at Multan perfectly sum up the unit's fighting spirit. No. 31 is one of two dedicated attack helicopter units in the Pakistan Army.



A No. 31 Squadron Bell AH-1S Cobra flies in formation with a No. 3 Squadron Cessna O-1.

Below: This Bell 206 JetRanger II serves in the liaison role at Dhamial Army Aviation Base.

Damaged in a landing accident, this Lama is used as a ground instructional airframe at Dhamial.

Below: No. 5 Squadron at Dhamial operates the Alouette III, some of which are Romanian-built.

One of No. 25 Squadron's Dhamial-based Pumas. The squadron also has a detachment at Gilgit.

No. 31 Squadron again. The word 'attack' is made into a Cobra silhouette.

Right: No. 32 Squadron operates the AH-1S and is co-located at Multan beside the similar No. 31 Squadron.

Nos 31 and 32 Squadrons use Bell 206 JetRanger IIs in the scout role, beside their AH-1s.

Below: No. 21 Squadron at Multan operates a handful of Bell UH-1Hs alongside its Pumas.

This PAC MFI-17 Mushshak is used for aerobatic demonstrations and is operated from Rahwali.

Below: This stunningly painted Army Aviation School O-1 was previously used for demonstrations.

No such condition was attached by Iran to its donation of 10 AB 205As in 1974. The same year saw the adoption of the Saab MFI-17 for liaison and training, following evaluation of a number of light aircraft, including the Scottish Aviation Bulldog (which was judged too expensive) and the SOCATA Rallye. An initial batch of 115 was procured for military use, 23 complete aircraft, and 92 in kit form for assembly at Risalpur. The local name Mushshak was applied almost immediately. All MFI-17 production was transferred from Sweden to Kamra in Pakistan during 1983. Pakistani production has now exceeded 140 aircraft, and an order book standing at 190 includes 115 for the Pakistan Army.

In 1975 12 Bell 206Bs were obtained from the USA, and these were later augmented by several JetRanger IIIs from 1981. Medium-lift and assault helicopter capability was dramatically expanded in 1976, with an order for 32 Aérospatiale SA 330J Pumas, which were delivered to two squadrons. A requirement for further (Romanian-built) Pumas remains unfulfilled due to budgetary constraints, but Puma spares have been obtained from IAR.

The Pakistan Army's long-standing requirement for an armed attack helicopter was filled in March 1985, with the formation of the first of two AH-1S Cobra squadrons. Twenty aircraft were delivered from 1984, armed with BGM-71 TOW missiles, but a requirement for 20 more seems unlikely to be fulfilled in view of the current US arms embargo, and a 1990 offer of 10 aircraft (for $89 million under the FMS programme) seems to have been withdrawn. The two Cobra squadrons each operate a handful of Bell 206s as scouts.

At one time, Pakistan hoped to acquire between 75 and 100 light observation/armed scout helicopters to augment the Cobras, but although the Gazelle and BO 105 were evaluated, and the Bell 206B reportedly selected, the requirement remains unfulfilled.

The Army Aviation School at Rahwali (it moved from Dhamial in 1988) trains all Army pilots, and helicopter pilots for all three services. The *ab initio* course lasts 44 weeks and provides 200 hours on the Mushshak and 90 hours on the O-1. The latter aircraft is used to teach the rudiments of nap-of-earth flying and short field take-offs and landings. Helicopter conversion follows, with a 14-week course encompassing 60 hours on the Bell 47 and Bell 206. Various types have been evaluated as potential Bell 47 replacements, whose retirement is imminent. Puma and Mi-8 co-pilots conversion is undertaken at Rahwali by detached aircraft, and at squadron level. Aircraft commanders must have at least 50 hours on type. The Pakistan Army has a policy of ensuring that all aircrew are multi-type rated.

Rotary wing instructors are trained at Rahwali in a 14-week/60-flying hour course on the Bell 206 and Bell 47, but fixed-wing instructors train at the PAF Air University at Risalpur. Communications and liaison duties are performed by a small fleet of light fixed-wing aircraft, including a Beech U-8F Seminole, two Rockwell Turbo Commander 690s and a Cessna 421 Golden Eagle. The Army also operates a single Commander SMA Jetprop 840 equipped for survey duties on behalf of the Surveyor General, and a McDonnell Douglas Helicopters MD-500E, which is operated on behalf of the shadowy Inter-Service Intelligence Department, which played a major role in supplying Afghan resistance movements with US arms. Plans to procure up to 100 SIAI Marchetti SM.1019s as O-1 replacements, and to acquire 24 Cessna 337s for liaison and medevac duties, were abandoned.

The Pakistan Army also includes four anti-aircraft brigades, equipped with Bofors RB-77 SAMs, Stingers and a variety of cannon and heavy machine-guns, from 12.7-mm to 40-mm calibre. A Sino-Pakistani shoulder-launched SAM is under development for the Army.

Order of Battle

UNIT	EQUIPMENT	BASE
No. 2 (Composite) Sqn	Bell UH-1, Cessna O-1, MFI-17 Mushshak	Lahore
No. 3 (Composite) Sqn	Cessna O-1, MFI-17 Mushshak	Multan
No. 4 Sqn	Mil Mi-8	Dhamial
No. 4 Sqn (Det)	Mil Mi-8	Rahwali
No. 4 Sqn (Det)	Mil Mi-8	Gilgit
No. 5 Sqn	Alouette III	Dhamial
No. 6 Sqn (ERC)	Bell UH-1H, AB 205A-1	Dhamial
No. 7 (Composite) Sqn	Cessna O-1, MFI-17 Mushshak	Sharea Faisal
No. 8 Sqn	Aérospatiale Lama	Dhamial
No. 8 Sqn (Det)	Aérospatiale Lama	Skardu
No. 9 (Composite) Sqn	Alouette III, Cessna O-1, MFI-17 Mushshak	Peshawar
No. 13 (Composite) Sqn	Cessna O-1, MFI-17 Mushshak	Dhamial
No. 21 Sqn	Aérospatiale Puma, Bell UH-1H	Multan
No. 25 Sqn	Aérospatiale Puma	Dhamial
No. 31 Sqn	Bell AH-1S, 206	Multan
No. 32 Sqn	Bell AH-1S, 206	Multan
Army Aviation School	Bell OH-13, MFI-17 Mushshak	Rahwali
VIP Flight	Cessna 421, Rockwell Turbo Commander	Dhamial
Air Force Academy	includes Army MFI-17 Mushshaks	Risalpur
Army Aviation Engineering School		
503 Workshop		Dhamial
Emergency Relief Cell	Bell 205	Dhamial
Frontier Corps	Bell 206	Dhamial

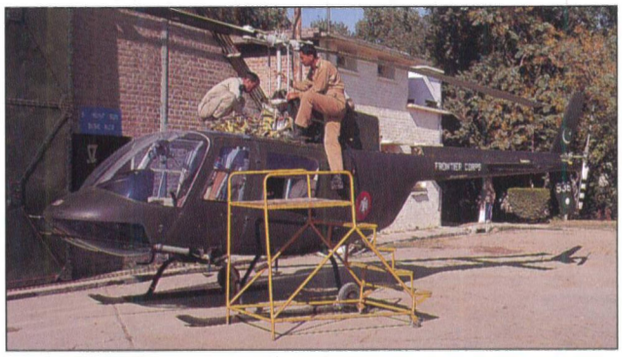
Pakistan Naval Aviation

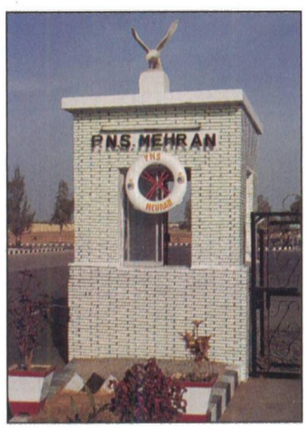
Pakistan's Navy is a lean but powerful force, tasked with keeping open Pakistan's sea lines of communication and defending Karachi, the country's sole port. The Navy will assume greater importance if a 1989 plan is carried out, to build new commercial ports at Gwadar and Pasni and a naval base at Ormara. Pakistan's position also offers it the potential of becoming the sea outlet for landlocked Afghanistan and the Central Asian states of the former USSR. The Navy is equipped with a single 'County'-class destroyer, 13 'Leander'-, 'Gearing'-, 'Garcia'- and 'Brookes'-class frigates, and eight Chinese-built fast attack craft, and is taking delivery of three French minehunters. These will augment two aging coastal minesweepers and up to five inshore minesweepers. The Navy also operates six submarines. The destroyers and frigates all have helicopter platforms, and most can accommodate a Sea King.

The requirement for a naval aviation element was graphically illustrated during the 1971 war against India, which demonstrated that ASW capability was sadly lacking. Accordingly, Pakistan formed a second-line training, SAR and fleet support unit equipped with four

The Army Aviation School at Rahwali operates the last few surviving Bell OH-13s in the training role.

Below: This Bell 206 is one of several used by the paramilitary Frontier Corps from Dhamial.





The main gate at PNS Mehran, which as Sharea Faisal also accommodates army and air force units.

A dummy Exocet (primary ship-killing weapon of the Sea King) stands outside PNS Mehran.

This radar- and flotation-gear-equipped SA 316 Alouette III is from No. 333 ASW squadron.

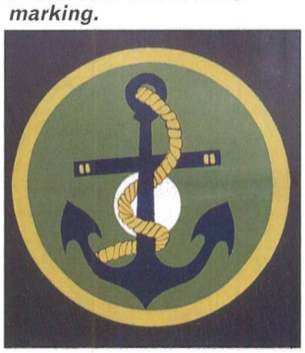
Below: The Pakistan Navy's second Fokker F27-200 wore its old Air Queensland colours for some months.

This Cessna 421 Golden Eagle is operated by Dhamial for communications work, and for VIP transport.

Below: One of two Rockwell Turbo Commanders in use with the Army's VIP Flight at Dhamial.

All Pakistani Bell 205s are operated by Army personnel on behalf of the government's Emergency Relief Ceil.

Below: Naval aircraft wear this anchor and roundel marking.

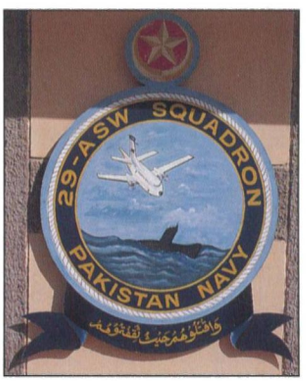


The Westland Sea King HAS.Mk 45 is equipped with the AM39 Exocet, and is fitted with intake filters.

Below: A No. 333 Squadron Alouette III makes a practice landing on the deck of PNS Taimur.

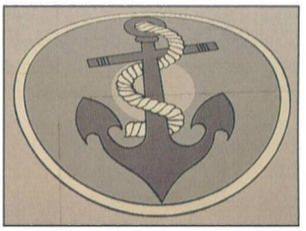
Below: One of No. 29 Squadron's four Breguet Atlantics patrols over the Arabian Sea.

One of No. 111 Squadron's Sea King HAS.Mk 45s lowers its dipping sonar during an ASW exercise.



The badge of No. 29 Squadron, which operates four Breguet Atlantics, whose armament includes the deadly Exocet.

Below: The toned-down version of the Pakistan Navy roundel.



The first Navy Fokker F27 wears a suitably maritime colour scheme, and has been upgraded to full maritime patrol configuration.

This Lockheed P-3C was one of three marooned in the USA when arms deliveries were halted under the terms of the Pressler amendment.

Aérospatiale Alouette IIIs, and also procured six Westland-built Sea King HAS.Mk 45s for use by a front-line ASW squadron, with a further aircraft (HAS.Mk 45A) following as an attrition replacement in 1989. Several of the Sea Kings are compatible with the AM39 Exocet, giving the squadron a useful anti-ship capability. Two of the Alouettes were also lost, but these were replaced by better-equipped examples of the same type. The latter replacement aircraft are fitted with radar and a MAD bird, and are capable of launching the Mk 44 torpedo. The latter weapons are reportedly being upgraded to Mk 46 standards. All four Alouettes can be fitted with flotation gear for overwater operation if required.

Land-based maritime patrol was originally left in the hands of the PAF, whose No. 29 Squadron was formed at Sharea Faisal in late 1975 to operate three ex-Aéronavale Dassault-Breguet Atlantics. These wore Pakistan Navy titles, but were flown by PAF aircrew. The Atlantics were augmented in 1982 by a pair of Fokker F27s transferred from PIA to equip No. 27 Flight (the Navy's first fixed-wing unit). These were initially intended purely for pilot training, but proved an effective surveillance platform. They were accordingly upgraded to F27MPA standard by Fokker in 1985, with AN/APS-504(V)2 search radar and underwing stores pylons.

The delivery of two more second-hand F27s (one of which went to the para-military Maritime Security Organisation) in 1988 allowed No. 27 Flight to assume squadron status. Both will be converted to MPA configuration. Because the F27s are used for VIP and liaison flying (sometimes to overseas locations) as well as surveillance and training, they retain civil registrations alongside their military serial numbers. A fourth (ex-Dutch) Atlantic was refurbished by Dassault and delivered to No. 29 Squadron in October 1988, before the unit transferred to naval control. The Atlantics are armed with depth charges and torpedoes for the ASW role, and with Exocets for anti-shipping strikes.

Plans to procure six ex-Australian P-3Bs came to nothing, and a planned order for eight F27MPAs was similarly abandoned, although a third Navy F27 was delivered in July 1992 and a fourth may be on order. Three Lockheed P-3Cs were eventually ordered in 1987, but delivery was halted after the suspension of US military aid, after the aircraft had been fully painted in Pakistan Navy markings and were already being used for crew training (Pakistani crews completed 18 months of training in the USA). As an interim measure Pakistan is seeking further Atlantics, which are augmented in the anti-shipping role by an Air Force squadron of Exocet-equipped Mirages. The same US arms embargo also halted delivery of three Kaman SH-2F and three Kaman SH-2G helicopters for the Navy's 'Badr'- and 'Khyber'-class frigates.

Order of Battle

UNIT	EQUIPMENT	BASE
No. 111 Sqn 'Sharks'	Sea King HAS.Mks 45/45A (5,1)	PNS Mehran
No. 333 Sqn	SA 316 Alouette III (4)	PNS Mehran
No. 27 Sqn	Fokker F27-200 (2)	PNS Mehran
No. 29 Sqn	Breguet Atlantic (4)	PNS Mehran

Sri Lanka's token fighter force consists of four single-seat F-7Ms, a two-seat FT-7 and two FT-5s. These equip No. 5 Squadron at Katunayake.

This is one of two Shenyang FT-5s in use for jet conversion, standardisation and training.

Below: One of Sri Lanka's Bell 212 gunships, which serve with No. 4 Helicopter Wing.

Republic of Sri Lanka

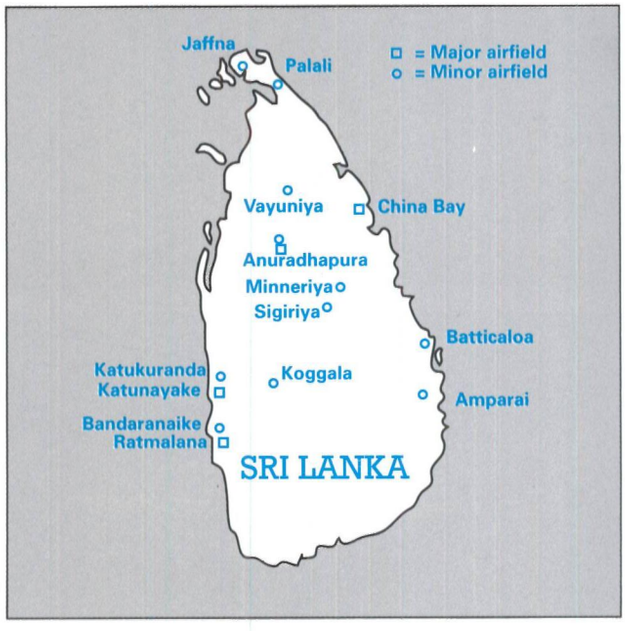
Sri Lanka Air Force

This small air arm had its origins as the Royal Ceylon Air Force, formed with British assistance. An independent monarchy until annexed by Britain in 1792, Sri Lanka was known as Ceylon even after independence was gained in February 1948. Britain remained responsible for Ceylon's external security after independence, and maintained bases at Colombo and Trincomalee until the late 1950s. The Royal Ceylon Air Force was formed on 1 October 1951, operating various British-built aircraft like the Boulton Paul Balliol and the Jet Provost. Traces of Britain's former influence remain to this day, with a handful of DHC-1 Chipmunks, DH Devons and DH Herons remaining on charge (though in storage), and a single Tiger Moth still in use. American assistance began in 1968 with the delivery of three Bell 206s; six Bell 47s were delivered in 1971. A republic was proclaimed in 1972, and this was accompanied by an increase in Soviet assistance.

The Soviet connection brought with it the establishment of a small but potent combat element (the Jet Provost's close support capability being little more than nominal) with the delivery in April 1971 of five MiG-17s and a single MiG-15UTI. These were accompanied by a pair of Kamov Ka-26 helicopters. Following India's example, Sri Lanka determined not to rely on a single source for its military equipment, and four further JetRangers, four Cessna 337s and six Cessna 150s were obtained from the USA, the fixed-wing types being acquired with MAP funding. The early 1970s also saw the delivery of a Convair 440 and two C-47s, primarily for tourist flying.

There was soon found to be no need for a combat element, and the MiGs were quickly relegated to long-term storage, while tourist flying assumed a greater and greater importance, with No. 4 Wing officially functioning as SLAF Helitours. Two Aérospatiale Dauphins (now withdrawn from use due to unserviceability) were procured in 1977, and procurement of the BAe 748 began with the transfer of one aircraft from the national airline in 1979 to replace the Convair. Since then, the air force has received six more Avros (as the 748 is inevitably known in India and Sri Lanka), the latest two of which are on lease to Air Lanka, while another acts as a spares source.

Another new type destined to become a Sri Lankan stalwart was the Bell 212, 12 of which were eventually delivered from 1983, the last three in tactical anti-infra-red olive drab, but without weather radar. Nine Bell 212s have since been fitted as gunships, alongside the four Bell 412s acquired in 1985. One-off types procured included a Pazmany PL-2 home-built and an ageing Beech 18, the latter a dedicated survey



On the troubled island of Sri Lanka, the days when the air force could function merely as a tourist carrier are long gone.

The badge of No. 1 Flying Training Wing at Anuradhapura is applied to the unit's SF.260s.

One of two ex-demonstrator SF. 260TPs sold to Sri Lanka during 1987 still wear this bizarre camouflage.

Right: Twelve SF.260s (probably ex-Burmese) were procured during 1990 via a Belgian dealer.

The remaining SF.260TPs serve in the COIN role, albeit under the auspices of No. 1 FTW.

Below: Two unserviceable SA 365Cs have not yet been flown by the unit to which they were transferred.

One of No. 4 Wing's Bell 212s, some of which have been converted to gunship configuration.

Below: This newly rebuilt de Havilland Tiger Moth is the latest addition to the Sri Lanka Air Force inventory.

This is a mixed formation of Bell 206, Bell 212, and Bell 412, the major types in service with No. 4 Helicopter Wing at Katunayake.

Six PT6-engined Harbin Y-12s were delivered for use by No. 2 Transport Wing at Ratmalana.

and mapping platform donated by Canada.

1983 marked the outbreak of violence by Tamil separatists in the north of the island, and this led to a dramatic increase in defence spending and a sudden shift in priorities for the air force, which had become little more than a tourist airline. The Sri Lanka Air Force was quickly committed to the fighting against the Tamil rebels, with helicopter gunships and bomb- and rocket-carrying light aircraft being used in anger against the rebels. Light transports were pressed into service as maritime patrol aircraft, trying to stop the flow of arms from India across the Palk Strait. The latter types included the new Beech Super King Air 200 delivered in 1983, and two additional Cessna Skymasters delivered in 1984. The colourful red and white airline-type colour scheme has been replaced on many aircraft by tactical olive drab camouflage.

The emergency also prompted major changes in infrastructure, with the air force HQ transferring from Katunayake to Ratmalana, and with improvements to runways at China Bay. Fourteen World War II airfields have also been earmarked for use as training bases (in the south) or as forward operating bases (in the north). These include Amparai, Anuradhapura, Batticaloa, Katukuranda (Negombo), Koggala, Minneriya, Sigiriya, Vayuniya and Weeranwila. Palali regional airport is also used as an FOB.

Sri Lanka received its first dedicated COIN aircraft in November 1986, in the shape of six SIAI SF.260TPs. Two were lost within a year, but attrition replacements were obtained in the form of the two factory demonstrators (and possibly a third aircraft). Aircraft procurement has continued at a steady pace, with six Harbin Y-12s being delivered in 1986 (at the knock-down price of $25,000 each). These have since been modified as makeshift bombers, carrying a load of 1,000 lb (454 kg).

1990 saw a radical shake-up of the training system, with the final retirement of the Chipmunk and the Cessna 150 (though two of the latter were retained for liaison duties). The two types were replaced by 12 (possibly ex-Burmese) SF.260s, which have since been joined by the SF.260TPs in the training role. These have been freed from front-line duties by the delivery of jet fighters from China. First to arrive was a pair of Shenyang FT-5s (two-seat MiG-17 copies) in July 1991. These were followed by a Guizhou FT-7 in October, and finally by four Chengdu F-7Bs in December 1991. These aircraft are more basic export versions of the Chengdu J-7II and are thus different to Pakistan and Bangladesh's F-7Ps, with a low-mounted pitot probe and only two underwing pylons.

Between 1987 and 1990, India provided a peacekeeping force in Sri Lanka, backed by Mil Mi-8, Mi-17 and Mi-25 helicopters and An-32 transports. This cost the Delhi government an estimated $1 million per day, and its withdrawal left the north of the island in Tamil hands. The war against the Tamils continues and has cost the air force at least one of its helicopter gunships. Others have been badly damaged, so a Bell 212 repair jig was purchased, and the Sri Lanka Air Force is rapidly becoming expert in the repair of battle damage.

Order of Battle

UNIT	EQUIPMENT	BASE
No. 1 Flying Training Wing	SF.260, SF.260TP, Cessna 150	Anuradhapura
No. 2 Transport Wing	Cessna 421, Beech 18, Beech Super King Air 200, Harbin Y-12, BAe 748, Shaanxi Y-8, DH.82 Tiger Moth	Ratmalana
No. 3 Maritime Sqn	Cessna 337	China Bay
No. 4 Helicopter Wing	Bell 212, 412, 206, Aérospatiale SA 365C Dauphin	Katunayake
No. 5 Jet Sqn	Shenyang FT-5, Guizhou FT-7, Chengdu F-7B	Katunayake

Several airworthy DHC-1 Chipmunks, DH Devons, DH Herons and Riley Herons are in storage at Ratmalana.

Maintained and operated by No. 2 Transport Wing, this Cessna 421 is used on behalf of the Survey Department.

Below: A Super King Air 200 purchased for VIP use was delivered in red and white, and since camouflaged.

No. 3 Maritime Squadron at Trincomalee (China Bay) operates six Cessna 337 Skymasters, four of which wear this red and white scheme.

Two surviving Cessna 150s are used for liaison, having been retired from training duties.

Below: The Sri Lankan Air Force Riley Herons have been withdrawn from use and are in open storage.

Republic of the Seychelles

Seychelles Peoples Air Force

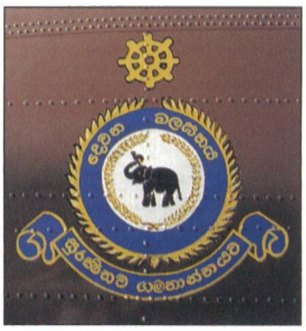
Although the 92 islands which comprise the Seychelles are located closer to the African continent than to the Indian sub-continent, they are closer to India ethnically, culturally and in their traditions. Discovered by the Portuguese, the islands were settled by the French and then conquered by the British, becoming a separate Crown Colony in 1903 and gaining independence in June 1976. A 1977 coup installed President Rene, who has since steered a non-aligned course, receiving aid, equipment and training from the USSR, India, Tanzania and Britain.

The country's air force originates from the Police Air Wing, which operated a single civil-registered Britten Norman BN2A-21 Islander. A second Britten Norman twin, this time a maritime reconnaissance-configured Defender, was ordered for the Defence Force in 1979, but is believed to have been delivered to the Navy. After an abortive coup in 1981, when 44 largely South African mercenaries landed on the islands, the Republic strengthened its armed forces, with Tanzania assisting in the training and equipment of the Defence Force and a part-time militia. The air force was established as an Air Wing of the Defence Force, receiving two SOCATA Rallye 235E light aircraft donated by Libya in May 1980, though one crashed in December 1988. India donated a pair of HAL Chetak (Alouette III) helicopters in 1982, replacing one after it crashed during 1987. In 1984 a second-hand Swearingen Merlin IIIB was delivered, and the original Police Islander transferred to military markings in 1988. The primary role of the air arm is maritime patrol and surveillance. According to some reports a second Merlin IIIB was delivered to the Navy, which may also operate two additional Chetaks.

Unconfirmed reports also suggest that the Seychelles Peoples Air Force now operates a Citation V, and a Cessna F406 Caravan II for maritime patrol, and that the Merlin IIIB (or IIIBs?) were sold in 1989. A Cessna 152 has apparently been acquired for training, to augment the surviving Rallye.

Two Shaanxi Y-8s (Chinese-built An-12s) were delivered, but one was lost in July 1992.

Right: This former Austin Airways Avro 748 wears a very stark camouflage.



The elephant badge of No. 2 Transport Wing clearly shows the RAF influence on the SLAF.

Two ex-British Airways and Scottish European Avro 748s delivered in December 1991 were leased to Air Lanka.

Below: A Jet Provost, a MiG-17 and this MiG-15UTI survived years in storage and are now in the museum.

The former Avro 748 demonstrator joined the Sri Lankan Air Force in 1986, and retains its BAe camouflage.

Below: Several Chipmunks remain fully airworthy, but are in storage at Ratmalana following their 1990 retirement.

The Gipsy-engined Herons were withdrawn from use due to engine overheating, but remain in storage.

Below: No. 3 Maritime Squadron has now relegated its de Havilland Doves to storage at Ratmalana.

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